
Supplement to Final Environmental Statement

related to construction and operation of
Clinch River Breeder Reactor Plant

Docket No. 50-537

U.S. Department of Energy
Tennessee Valley Authority
Project Management Corporation

Main Report

**U.S. Nuclear Regulatory
Commission**

Office of Nuclear Reactor Regulation

October 1982



SUMMARY AND CONCLUSIONS

Supplement Number 1 to the Final Environmental Statement (FES) relative to construction and operation of the Clinch River Breeder Reactor Plant was prepared by the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, in cooperation with the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency.

1. This action is administrative.
2. The proposed action is the issuance of a construction permit to the Project Management Corporation (PMC), the Tennessee Valley Authority (TVA), and the U.S. Department of Energy (DOE) for construction and operation of the Clinch River Breeder Reactor Plant (CRBRP), Docket No. 50-537. The proposed location is in Roane County, Tennessee, about 25 miles west of Knoxville, on the north side of the Clinch River. The site is within the city limits of Oak Ridge, but it is owned by the United States of America and is presently in the custody of TVA. The United States (DOE) would also own the plant.* Site preparation began in September 1982 upon authorization of such activities by the Commission. Completion of construction is scheduled for 1989, and reactor criticality is anticipated in February 1990.

During the first 5 years of operation (1990-1995), TVA would operate the CRBRP and purchase its electrical output as a demonstration plant under DOE's Liquid Metal Fast Breeder Reactor (LMFBR) Program. At the end of that period, TVA would have the option of purchasing the plant for its own use over the remaining operating life of approximately 25 years.

The CRBRP is designed to use a liquid-sodium-cooled fast breeder reactor to produce 975 megawatts of thermal energy (MWt), with the initial core loading of uranium and plutonium mixed-oxide fuel. This heat would be transferred by heat exchangers to nonradioactive sodium in an intermediate loop, and then to a steam cycle. A steam turbine generator would use the steam to produce 375 megawatts of electrical capacity (MWe). Future core design may result in a gross power rating of 1121 MWt; this higher rating was considered in the assessments made in this statement.

Exhaust steam from the turbine generator would be cooled in condensers utilizing two mechanical draft cooling towers for dissipating heat to the atmosphere. The Clinch River would supply all CRBRP water needs. At full-power operation, the annual average water requirement would be about 13.6 cfs (6109 gpm), of which 5.4 cfs (2432 gpm) would be returned as blowdown to the river and 8.3 cfs (3730 gpm) would be consumed, mainly by evaporation.

*Legislation was enacted by the Congress in January 1976 which authorized the U.S. Energy Research and Development Administration (ERDA) to acquire ownership and custody of the CRBRP and custody of the associated site area. ERDA (now DOE) became a co-applicant on May 6, 1976.

3. Updated Summary of Environmental Impacts and Adverse Effects:

- (a) Some timber would be harvested and other vegetation and animal life would be destroyed on the 292 acres disturbed for construction of the plant facilities and the 61 acres of right-of-way for new transmission lines. All but 113.5 acres would be revegetated after completion of construction (Sections 4.2.1 and 4.4.1). (The land area disturbed for plant construction would be about 50% higher than indicated in the FES; this would still be a small percentage of similar resources on the Oak Ridge Reservation.)
- (b) Erosion of land and minor siltation of the river would result from construction and subsequent rainfall, but planned control practices and revegetation would minimize this effect (Section 4.4.2). (This item is unchanged from the FES.)
- (c) Approximately 63,000 ft² of river bank and bottom would be disturbed during construction of cooling water intake and discharge and barge-unloading facilities, improvement of the access road, and construction of the railroad spur; part of these areas would be lost temporarily as benthic habitat (Section 4.4.2). (The area of 63,000 ft² replaces the volume of 20,000 m³ given in the FES.)
- (d) Access to Hensley Cemetery on the site would be allowed; historic and archeological resources would not be affected by construction activities (Sections 5.1 and 4.2.1). (Reference in the FES to an Indian mound has been deleted because the remains in the mound have been curated at the University of Tennessee.)
- (e) Construction noise would be a temporary annoyance to a few residents south of the site (Section 4.5.6). (This item is unchanged from the FES.)
- (f) Construction traffic would add to congestion on local roads, particularly State Road 58, during shift changes (Section 4.5.3). (This item is unchanged from the FES.)
- (g) Tax receipts would probably compensate for increased public services needed by the additional work force during construction (Section 4.5.5). (This is a change from the FES, which indicated that tax receipts would not fully compensate for the increased public service.)
- (h) Transmission line structures would be largely concealed by ridges and hills. The plant would not be seen except from Gallaher Bridge and several residences south of the river (Sections 4.5.3 and 5.1). The cooling tower plume would usually extend no more than 1.5 miles, but could sometimes extend 6 miles. Fog resulting from the tower operation could be a minor nuisance on nearby roads a few hours per year (Section 5.3.3).
- (i) Deposition of dissolved solids carried with vapor from the cooling tower would have no important effect on vegetation and animals (Section 5.3.3). (This item is unchanged from the FES.)

- (j) Water consumed by the project would be a maximum of 210,000 gpd during construction and an annual average of 3730 gpm (8.3 cfs) during full-power operation. These figures are 5% and 4% more than in the FES, but the increases are environmentally insignificant. Water use during operation would be less than 0.2% of the annual average river flow (Sections 4.3 and 5.2).
- (k) The average annual radiation dose to an individual living at the site boundary would be less than 1 mrem/yr, and the cumulative dose to the estimated year 2010 population within 50 miles would be about 0.1 person-rem/yr. These doses are less than 2% and about 0.002%, respectively, of those received from natural radiation. The total dose to the general public from operation of supporting CRBR fuel cycle facilities and transportation of radioactive fuel and wastes from the CRBRP is estimated to be 170 person-rems/yr; this is not significant when compared to the estimated 28 million person-rems/yr received by the U.S. population from natural sources (Section 5.7.3). (These figures are higher than those in the FES primarily because of the more conservative assumptions used; however, as indicated here, these doses are not significant.)
- (l) Risks associated with accidental radiation exposure would be very low (Chapter 7). (This item is unchanged from the FES.)

4. Major alternatives considered were

- Sites
- Facility systems
- Transmission route

(This item is unchanged from the FES.)

- 5. The FES was made available to the public, to the Council on Environmental Quality, and to other specified agencies in February 1977. This supplement updating the FES is being made available in October 1982.
- 6. The Federal, state, and local agencies that were asked to comment on the Draft Supplement to the FES which was made available in July 1982 and those organizations and individuals that provided such comments will be sent copies of this assessment.
- 7. On the basis of the analysis and evaluation set forth in the Final Environmental Statement and this supplement, after the environmental, economic, technical, and other benefits of the Clinch River Breeder Reactor Plant have been weighed against environmental and other costs, and after available alternatives have been considered, the staff concludes that the action called for under the National Environmental Policy Act of 1969 (NEPA) and Title 10 of the Code of Federal Regulations Part 51 (10 CFR 51) is the issuance of a construction permit for the plant subject to the following limitations for the protection of the environment:

- (a) The applicants shall take the necessary mitigating actions, including those summarized in Section 4.6, during construction of the plant and associated transmission lines to avoid unnecessary adverse environmental impacts from construction activities.
- (b) In addition to the preoperational monitoring programs described in Section 6.1 of the Environmental Report, with amendments, the staff recommendations included in Section 6.1 of this assessment shall be followed.
- (c)* The applicants shall demonstrate to the satisfaction of the staff that, at the construction permit stage, the radiological consequences of postulated plant accidents will not exceed 150 rems to bone surfaces, 20 rems to the whole body, 35 rems to the lung, and 150 rems to the thyroid of an individual at the site boundary.
- (d) The applicants shall establish a control program that shall include written procedures and instructions to control all construction activities as prescribed herein and shall provide for periodic management audits to determine the adequacy of implementation of environmental conditions. The applicants shall maintain sufficient records to furnish evidence of compliance with all the environmental conditions herein.
- (e) Before engaging in a construction activity not evaluated by the Commission, the applicants will prepare and record an environmental evaluation of such activity. When the evaluation indicates that such activity may result in a significant adverse environmental impact that was not evaluated, or that is significantly greater than that evaluated in the Final Environmental Statement, as supplemented in 1982, the applicants shall provide a written evaluation of such activities and obtain approval of the Director of the Office of Nuclear Reactor Regulation prior to undertaking the activities.
- (f) If unexpected harmful effects or evidence of serious damage are detected during plant construction, the applicants shall provide to the staff an acceptable analysis of the problem and a plan of action to eliminate or significantly reduce the harmful effects or damage.

*Limitation (c) in the FES should have stated that "the applicant shall demonstrate to the satisfaction of the staff that the radiological consequences of postulated plant accidents will not exceed 15 rem to the bone, 20 rem to the whole body, 7.5 rem to the lung, or 150 rem to the thyroid of an individual at the site boundary (Appendix I)." In updating the FES, the staff has replaced the bone dose limitation with "150 rems to bone surfaces" and has replaced the 7.5 rem lung dose with "35 rems to the lung." Further discussion of these changes is given in updated Section 11.7.5.

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PREFACE

In February 1977, the Office of Nuclear Reactor Regulation issued a Final Environmental Statement (FES) (NUREG-0139) related to the construction and operation of the proposed Clinch River Breeder Reactor Plant (CRBRP). That FES was prepared by the Nuclear Regulatory Commission (NRC) staff in cooperation with representatives of the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency.

Since the FES was issued, additional data relative to the site and its environs have been collected, several modifications have been made to the CRBRP design, and its fuel cycle, and the timing of the plant construction and operation has been affected in accordance with deferments under the DOE Liquid Metal Fast Breeder Reactor (LMFBR) program. These changes are summarized and their environmental significance is assessed in this document. The reader should note that this document generally does not repeat the substantial amount of information in the FES which is still current; hence, the FES should be consulted for a comprehensive understanding of the staff's environmental review of the CRBRP project.

This supplement was first issued as a draft on July 19, 1982, and a 45-day period was provided for public comment. The comments received are reproduced in Appendix N and they have been considered in the preparation of this supplement. The staff's consideration of those comments resulted in the preparation of the responses that are found in Chapter 12 and in limited modifications of the text in other parts of the document.

The staff has concluded that environmental impacts have changed in some instances from those reported in the FES. However, the staff's overall conclusion remains the same as in the Summary and Conclusions of the FES; that is, the action called for is the issuance of a construction permit for the plant, subject to certain limitations for the protection of the environment.

FOREWORD

This supplement was prepared by the Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission (NRC, the staff), in accordance with the Commission's regulation, Title 10 of the Code of Federal Regulations Part 51, which implements the requirements of the National Environmental Policy Act of 1969 (NEPA). The U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (the Corps) participated in the preparation of this assessment.

The rest of the FES foreword remains unchanged except as follows:

Mr. Paul H. Leech is the NRC Project Manager for environmental review of this project. Should there be questions regarding the content of this statement, Mr. Leech may be contacted by telephoning 301/492-4503 or by writing to the following address:

Clinch River Breeder Reactor Program Office
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Copies of this statement may be obtained as indicated on the inside front cover. Copies are also available for inspection at the NRC Public Document Room, 1717 H St., NW, Washington, DC; the Oak Ridge Public Library, Civic Center, Oak Ridge, TN; and the Lawson McGhee Public Library, 500 W. Church St., Knoxville, TN.

1 INTRODUCTION

1.1 The Proposed Project

The Clinch River Breeder Reactor Plant (CRBRP) is the demonstration plant proposed by the U.S. Department of Energy (DOE) under its Liquid Metal Fast Breeder Reactor (LMFBR) Program.

1.2 The Project Participants

The project participants remain as stated in the Final Environmental Statement (FES), except that DOE has succeeded the U.S. Energy Research and Development Administration (ERDA) as the lead applicant. The applicants (sometimes identified as DOE in this document) also include the Project Management Corporation (PMC) and the Tennessee Valley Authority (TVA).

1.3 Status of the Project

Completion of construction was scheduled for late 1981 and initial operation in 1982. However, President Carter decided in April 1977 to defer any U.S. commitment to advanced nuclear technologies that were based on plutonium. In keeping with that decision, the applicants requested the NRC Atomic Safety and Licensing Board (ASLB) to suspend the CRBRP licensing proceedings, which it did in May 1977.

On October 8, 1981, President Reagan announced that he was lifting the suspension on commercial reprocessing, and he directed government agencies to proceed with the demonstration of breeder reactor technology, including completion of the CRBRP. Accordingly, at DOE's request, the ASLB conducted a prehearing conference on February 9 and 10, 1982, for the purpose of resuming the licensing proceedings.

By letter dated November 30, 1981, the applicants requested the Commission to authorize, under Title 10 of the Code of Federal Regulations Part 50 Paragraph 12 (10 CFR 50.12), the conduct of site preparation activities beginning in March 1982. That request was denied by the Commission's Order Number CLI-82-4 dated March 16, 1982. On May 16, 1982, DOE requested the Commission to reconsider its Order, but the Commission, in an Order dated May 18, 1982, declined to do so.

By letter dated July 1, 1982, the applicants again requested the Commission to authorize the conduct of site preparation activities beginning in August 1982. That request was granted by a Commission order dated August 17, 1982, and site clearing began on September 21, 1982.

Based on NRC's current projection that a limited work authorization could be issued for certain safety-related activities in August 1983, the applicants now plan to complete the construction of CRBRP in 1989. Initial reactor criticality is scheduled for February 1990; thus, the 5-year demonstration period will cover the years 1990 through 1994.

1.4 Status of Reviews and Approvals

The listing of the major documents used in the preparation of this assessment has been expanded to include the Supplement to ERDA-1535, issued as DOE/EIS-0085-FS in May 1982. Additional information was gained from site visits in January and November 1975, October 1981, and February 1982.

In ER Section 12, the applicants provided an extensive listing of licenses and permits applicable to CRBRP. That list has been revised to include:

<u>Permits and Licenses</u>	<u>Issuing Agencies</u>
15. Clean Water Act 401 certification	State of Tennessee
16. Permits relative to air quality	State of Tennessee

In addition, item (8) was revised as follows:

8. License for radio transmitters and associated towers	National Telecommunications and Information Administration
--	---

EPA issued a Public Notice of Proposed Issuance of an NPDES Permit and Consideration of State Certification of the NPDES Permit on or about June 24, 1982. (The proposed NPDES Permit, as amended in October 1982, is included as Appendix H to this assessment.)

The 401 certification of the NPDES Permit was issued by the State of Tennessee on July 15, 1982, and modified on September 21, 1982. A copy is included in Appendix H.

2 THE SITE AND ENVIRONS

2.1 General Description

In the first paragraph, the second sentence has been corrected to read as follows:

Nearby cities are Kingston, 7 miles west, and Harriman, 10 miles west-northwest. The residential sections of Oak Ridge are 9 miles to the northeast (FES Fig. 2.2).

As shown in FES Figure 2.3, the plant would cover 292 acres, about one-fifth of the 1364-acre site. This is an increase of about 50% over the 195 acres indicated in the FES and is considered in Section 4.2.1. One small industrial plant, which manufactures neutron absorbers, is now located on a 33-acre parcel of land in the Clinch River Industrial Park adjacent to the north plant site boundary. The rest of the 112-acre industrial park is undeveloped. As indicated in the FES, the principal industrial installations in the area are DOE's Oak Ridge Gaseous Diffusion Plant (ORGDP or K-25), DOE's Oak Ridge National Laboratory (ORNL) research and development facilities, the Y-12 area which provides research and production facilities for DOE's military program, and TVA's Melton Hill Dam (FES Fig. 2.2).

While the area has no major sports facility, over 60 recreational sites had, in all, about 10,000 people present during the peak hour in 1980; over 15,000 are anticipated in the year 2030 (ER Table 2.2-8). There are four recreational areas within 3 miles of the proposed site, including a small commercial campground located about 1.5 miles south-southeast. A public access area, which accommodates approximately 400 people per day, is also located about 1.5 miles from the site. The other two recreational areas, a visitor outlook and an incidental use area, accommodate about 100 people per day each; they are located about 2.5 miles from the site. A waterfowl refuge is 8 miles southwest on the Tennessee River, a wildlife preserve is at Kingston, and part of the Paint Rock Wildlife Management Area is also about 8 miles southwest.

The number of schools within 10 miles of the site decreased from 22 to 21 by 1981, while the total enrollment increased to 8870 students from nearly 8000 in 1973. A total of four hospitals, located at Oak Ridge, Harriman, and Loudon, are within 15 miles.

The Norfolk-Southern Railroad serves the ORGDP by way of a branch from the line about 2 miles northwest of the site (rather than 4 miles as stated in the FES).

Within a 20-mile radius of the site, 12 public water systems and 15 industrial systems draw from surface water, including the Clinch River and the Emory River. The closest such withdrawal is by DOE, 1.6 miles downstream, for ORGDP and the Clinch River Industrial Park. Groundwater supplies 13 public systems and many residences within the 20-mile radius. Over 100 such residences are within 2 miles, all located south of the Clinch River. The use of surface water for

fishing is considered in Section 2.7. Commercial traffic through the Melton Hill Dam increased from 1000 tons in 1966 to 12,000 tons in 1980. For the same years, the numbers of recreational craft dropped from 1200 to 284 (ER Sec 2.2).

Section 2.8 below further describes social and community characteristics of the area.

2.2 Regional Demography

Within a 50-mile radius from the plant, Knoxville and Oak Ridge are the largest urban centers, with 1980 populations of 183,139 and 27,662 respectively; 16 other centers have populations between 2500 and 15,000 (ER Table 2.2-1). In 1980 the 10-mile radial area had a resident population of 52,040, and the 50-mile area, 830,840. The corresponding estimates for 2030 are 67,580 and 933,280. Figure A2.1 shows population distributions for 1980 and 2030, from 0 to 10 miles and from 10 to 50 miles from the site.

The resident population within 10 miles of the site is increased by transients using roads, employees travelling into the area, and visitors to local parks or recreation areas. The 1980 resident-equivalent population within 10 miles was 19,640; this population is expected to grow to about 30,738 by 2030 (ER Sec 6.1.4.2.1). Employment at the ORGDP, ORNL, and Y-12 facilities is discussed in Section 5.8.

2.3 Historic and Archeological Sites and Natural Landmarks

The National Register of Historic Places through March 1982 shows five sites within 10 miles of the proposed CRBRP site: the Lenoir Cotton Mill (9.5 miles), the Harriman City Hall (10 miles), the Roane County Court House at Kingston (8 miles), the Southwest Point on the Tennessee River southwest of Kingston (8.5 miles), and the X-10 Graphite Reactor at ORNL (4 miles).

In October 1972 and January 1973, the applicants had the University of Tennessee conduct a historical reconnaissance site survey and a reevaluation of six archeological sites that were originally identified in a 1941 survey. The historical survey resulted in the identification of four farmsteads--recorded as 40RE120, 40RE121, 40RE122, and 40RE123--and the Hensley Cemetery (40RE119) within the site boundaries (FES Fig. 2.7). The structure 40RE123 was destroyed before detailed drawings and photographs of the farmsteads were completed. None of the sites and structures qualified for inclusion in the National Register of Historic Places. The State Historic Preservation Officer agreed with this conclusion after review of the report (Schroedl, 1972 and Thomas, 1973) submitted by Dr. Gerald F. Schroedl (FES App C).

Test pits were excavated at six archeological sites identified as 40RE104, 40RE105, 40RE106, 40RE107, 40RE108, and 40RE124. The tests indicated that 40RE107, 40RE108, and 40RE124 required further study, and the University of Tennessee contracted to do the additional work. Salvage work was completed in 1975 on the three sites. Site 40RE124 was the most important of these and indicated interment of more than 36 individuals. The materials from the sites were curated at the University of Tennessee. The results of the investigation have shown that no remaining sites were worthy of nomination for inclusion in the National Register (see the State Archeologist's letter in FES App C).

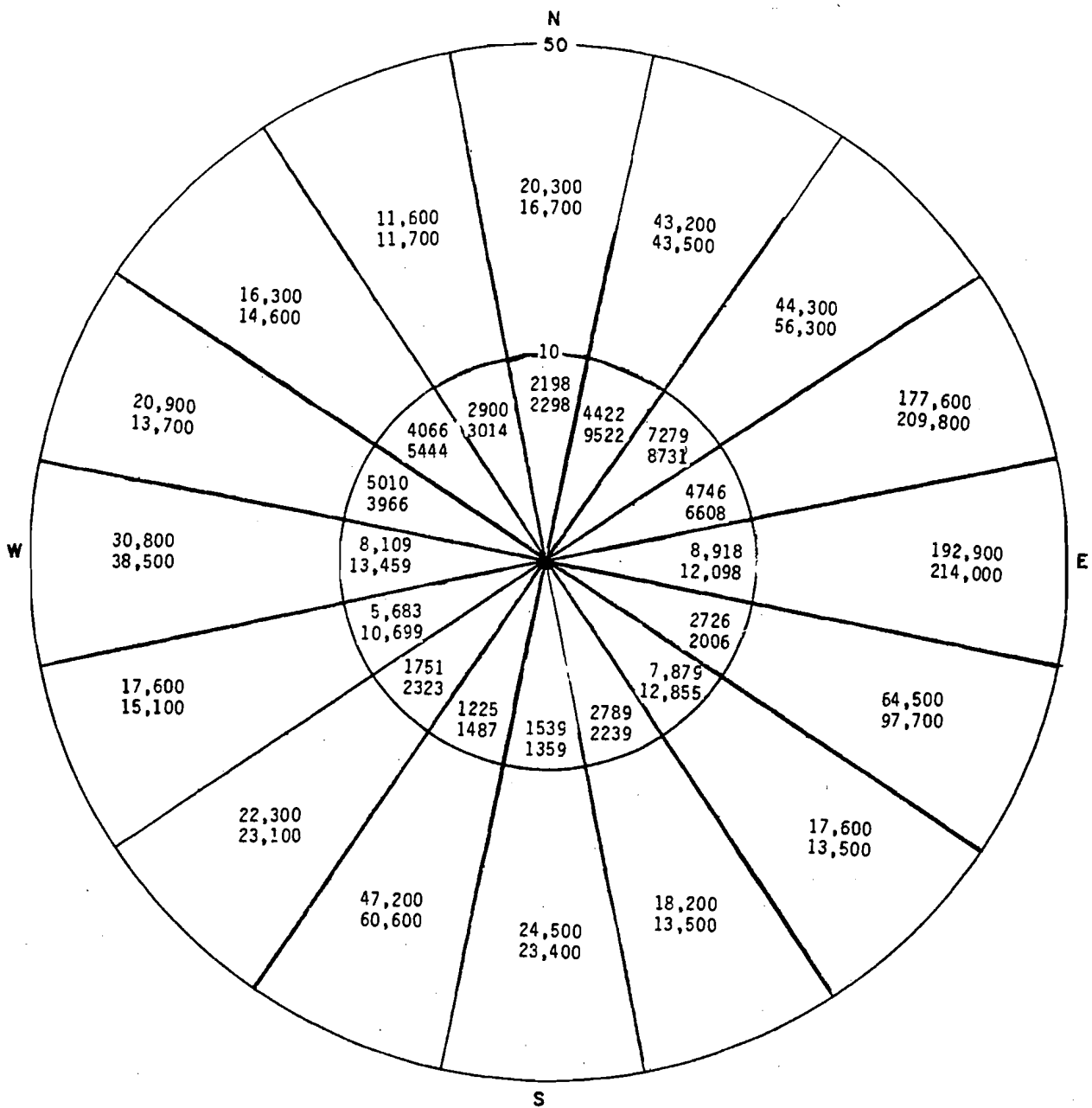


Figure A2.1 Population distributions within 10 and 50 miles of the proposed CRBRP site. The top number in each sector is the total for 1980; the bottom number is the estimate for 2030. The totals within a 10-mile radius include resident and transient population. (Replaces FES Fig. 2.6.)

An additional cultural resources study of unsurveyed portions of the project area was conducted in the winter of 1981-1982. The survey revealed no historic structures that would be directly impacted by the project (ER Am XIII, p. 2.3-4). Seventeen archeological sites and two loci were identified, all of which would be avoided by the construction and operation of the plant. Five of the sites (SS-2, SS-3, SS-5, T-17, and T-23) were thought to be potentially significant. If present plans should change and ground disturbance of the five site areas is anticipated, the applicants should contact the State Historic Preservation Office and the NRC before proceeding. (See Appendix C of this assessment for State Historic Preservation Office agreement with such conditions.) No natural landmarks are present on the plant site or in the vicinity.

The additional information above does not change the assessment in the FES that construction of the CRBRP is unlikely to impact cultural resources on site or in the vicinity (Sec 4.2.1 and 5.1).

2.4 Geology

This section of the FES has been rewritten for clarification but no significant changes have been made in the data presented.

The proposed CRBRP site lies in the Valley and Ridge Physiographic Province. The region is characterized by rugged terrain of subparallel ridges with intervening valleys. In the site vicinity, the major ridges (Chestnut Ridge to the northwest and Dug-Hood Ridge to the southeast) crest between 900 and 1200 ft. The ground surface of the valley between these ridges, known locally as Poplar Springs Valley and Bethel Valley, consists of rolling hills which range between elevations of 750 and 800 ft. The proposed site is on a broad but small peninsula formed by the meanders of the Clinch River. Within the site boundaries, Chestnut Ridge is comprised of two northeast-trending subordinate ridges, which reach a maximum elevation of about 900 ft. In the valley formed by these subridges, a topographic saddle rises to about 800 ft. The valley slopes from this saddle in both the northeast and southwest directions down to the Clinch River (normal summer pool elevation is 741 ft). Surface drainage of the site occurs along these slopes. Subsurface drainage takes place along solution-enlarged joints in areas directly underlain by limestone and dolomite.

The proposed site is in the Southern Valley and Ridge Tectonic Province near the western border of the Appalachian geosyncline, which was formed during the Paleozoic Era (570 million years before present (mybp) to 225 mybp). The sedimentary rocks within the Appalachian geosyncline were folded and faulted during the Paleozoic Era and are now tilted to the southeast at an angle of about 30°. Since the Paleozoic Era, the dominant geologic processes at the site, besides the general uplift of the region, have been weathering and erosion, with sediment accumulation restricted to terrace and floodplain deposits of the Clinch River.

The proposed site is between two major regional thrust faults, the Copper Creek fault, about 3000 ft southeast of the site, and the Whiteoak Mountain fault, 1.7 miles northwest of the site. No evidence of any post-Paleozoic activity associated with these faults has been found. The applicants performed radiometric dating (potassium argon) analyses of the faults and found them to be at

least 285 million years old. This finding is consistent with other age dating of thrust faults in the Valley and Ridge.

The proposed site is underlain by siltstones, limestones, and dolomites of Ordovician Age (500 mybp to 430 mybp). The rock in the vicinity of the proposed Category I structures is overlain by 1 ft to about 60 ft of clay residual soil.

Several minor faults and folds were found during site investigations. Displacements on the faults range from a few inches to several feet. Minor folds were also identified which had wavelengths and amplitudes of several feet. All of these structures are interpreted to have formed during late Paleozoic at the same time as the regional faults.

Four sets of joints were mapped at the site. The first two sets have strikes similar to that of the bedding (N52°E) and dip 37° southeast and 58° northwest, respectively. The third and fourth set of joints have strikes perpendicular to the bedding and dip 80° southwest and 75° northeast, respectively. The joints are spaced about 1 to 6 ft apart. Most of the joints are hairline fractures with surfaces that are stained by weathering. The most pronounced weathering and solution activity have been identified within outcrop bands of limestone and dolomite. Weathering and solutioning have advanced from these outcrops downward along steeply inclined joints and bedding planes, developing soil seams and cavities. It was found during investigations that, where unweathered siltstones overlay limestones and dolomites, weathering was minimal and there were no solution features. The plant is to be founded on that type of rock.

2.5 Hydrology

2.5.1 Surface Water

Data regarding the Melton Hill Dam have been revised. Based on 1963-1979 discharge records for the dam, the average flow of the river is about 5380 cfs at the site. The maximum hourly average release was 54,960 cfs on April 5, 1977, and the maximum daily average release was 34,966 cfs on January 11, 1974, (ER Sec 2.5.1.2 and PSAR Sec 2.4.1.2.4). These figures are 12 to 30% higher than reported in the FES, but they do not significantly affect the impact assessments in FES Chapters 4 and 5. In addition to the influence of the Melton Hill, Watts Bar, and Fort Loudon Dams discussed in the FES, river flow now also is influenced by the newly constructed Tellico Dam. Flow reversal could occur as a result of abrupt shutdown of the Melton Hill and Watts Bar Dams and by release of water from the Fort Loudon and Tellico Dams. The 1963-1979 flow data for Melton Hill Dam show that nearly all monthly averages exceeded 1000 cfs, except for periods of no flow (ER Table 2.5-2). No extended periods of zero flow are anticipated in the future; however, the applicants state: "Should the need arise for any regulation at Melton Hill Dam which would result in extended periods of zero release, the operations (at CRBRP) would be coordinated to meet flow requirements at the CRBRP site" (ER Sec 2.5.1.3).

Water temperatures were measured at Clinch River Mile (CRM) 21.6 between May 1963 and August 1979. The maximum temperature observed during this period of record was 78°F, and the minimum, 33°F. Table A2.1 shows the average daily maximum, minimum, and mean river temperatures for each month from 1963 to 1979.

These figures are revised slightly from those in the FES (ER Table 2.5-7), but the changes are not significant.

Table A2.1 Average daily maximum, minimum, and mean river temperatures for each month, 1963-1979*

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	44	44	50	56	62	65	66	67	69	66	58	50
Minimum	42	42	44	54	60	63	64	65	66	64	56	47
Mean	43	43	48	55	61	64	65	66	67	65	57	48

*CRM 21.6; temperatures in °F.

2.5.2 Groundwater

The second sentence in this section has been changed to read: "The weathered bedrock is about 30 to 60 ft thick and underlies a clay overburden that averages 17 ft in thickness."

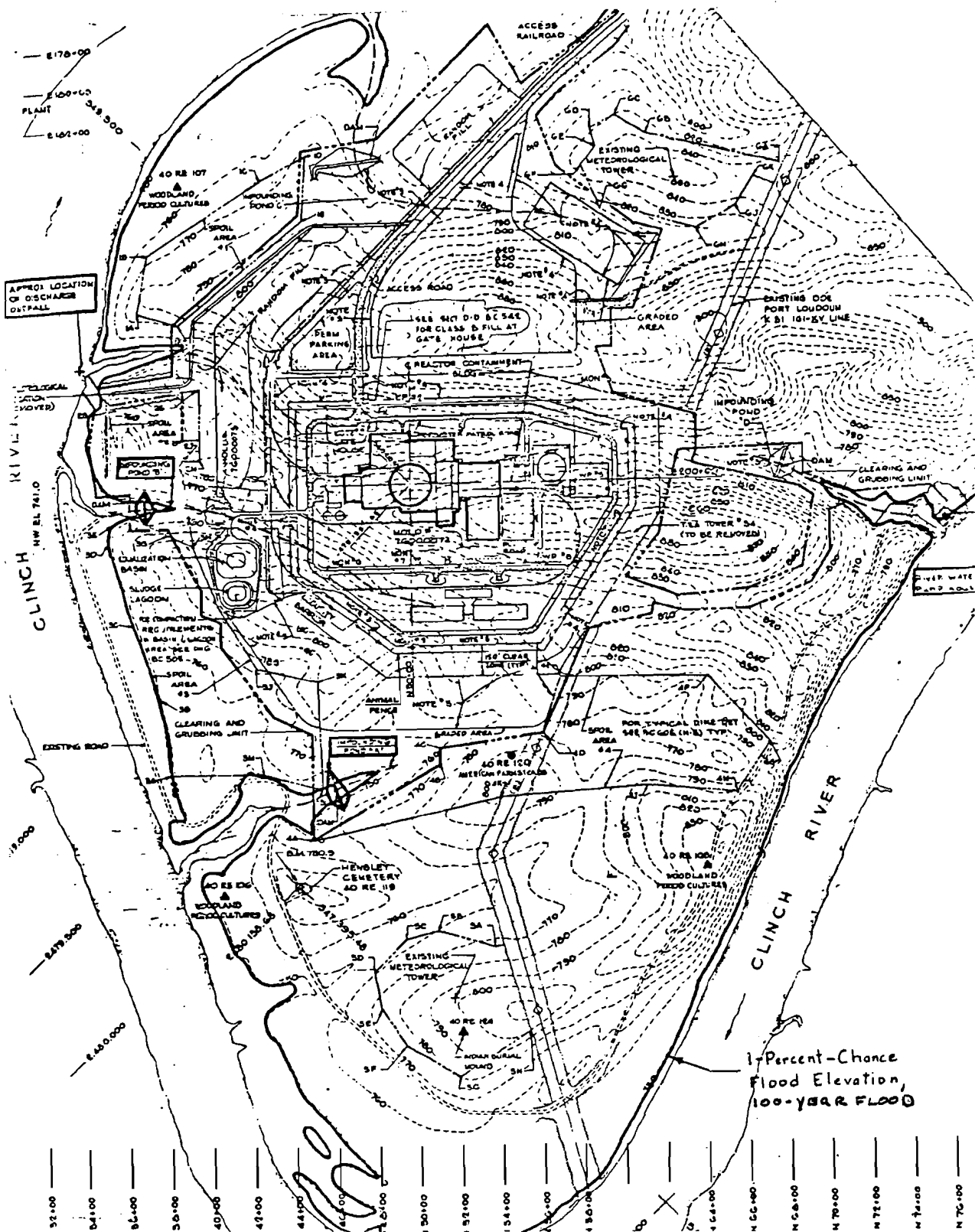
2.5.3 Floodplain Effects

Executive Order 11988, signed in May 1977, requires that there should be no construction in the base floodplain unless there is no practicable alternative. The necessary construction in the floodplain should be analyzed to determine its environmental effects and the potential for altered flood flows and levels. The base floodplain for the purposes of this study is defined as the lowland and relatively flat area adjoining the Clinch River that is subject to a 1% or greater chance of flooding in any given year (100-year floodplain).

Clinch River, Grassy Creek, and several intermittent streams flow through the site. The 100-year floodplain on the Clinch River and Grassy Creek is shown in Figures A2.2 and A2.3. Construction activities proposed in the 100-year floodplain include a limited amount of clearing and grubbing, and activities related to the construction of the runoff treatment ponds, the intake and pumphouse, the barge-unloading ramp, and the discharge structure.

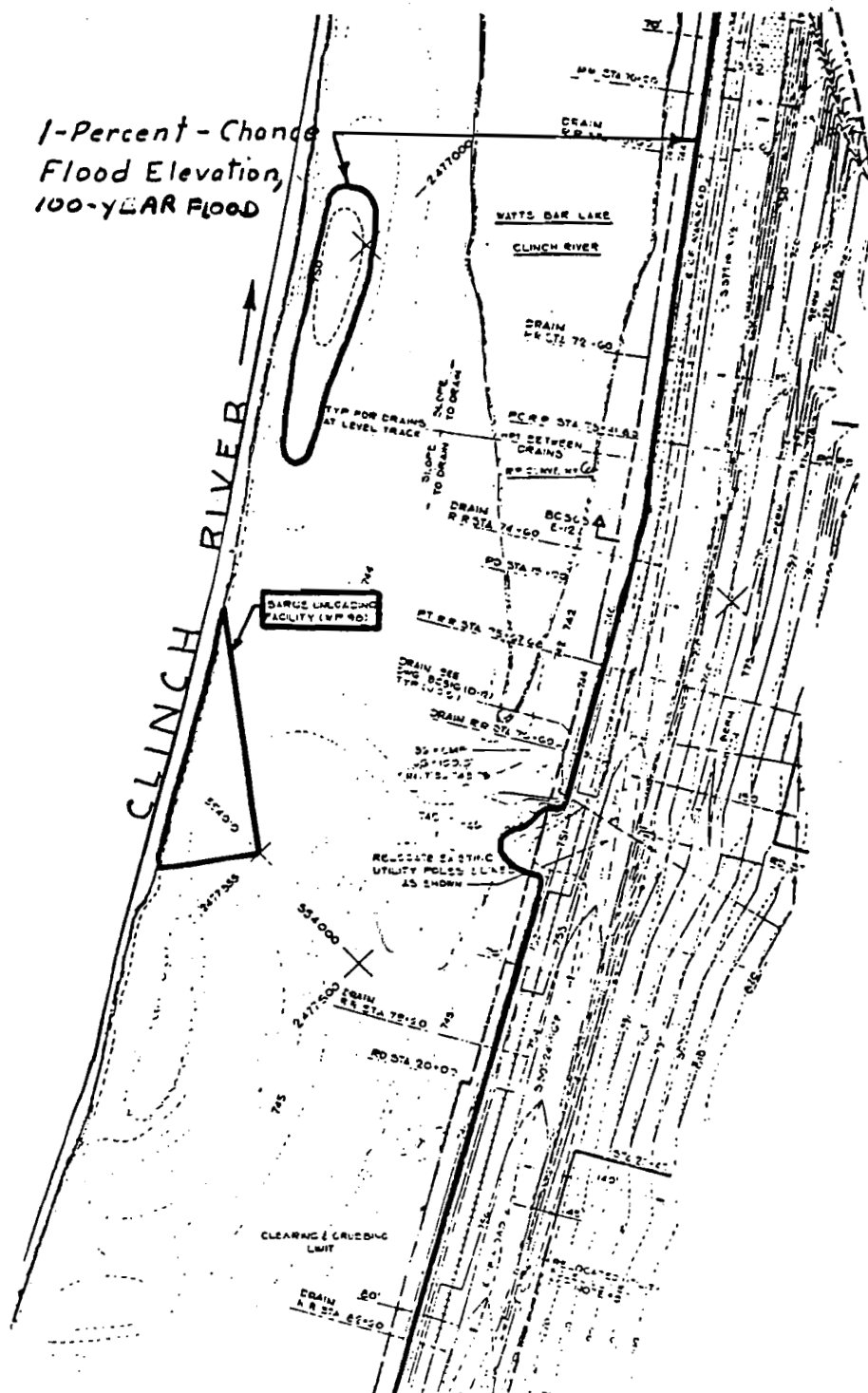
Plant features located in the 100-year floodplain would be the treatment ponds, river intake and pumphouse, barge-unloading facility, and the intake and discharge structure. All but one of the six treatment ponds (Pond C, NPDES 005) will be removed after construction is complete.

In addition, the plant access road and railspur would cross a portion of the 100-year floodplain. A temporary storage area would be built downstream from the site at about Clinch River Mile 13.8, and it would occupy a portion of the 100-year floodplain. This area has been used previously for construction storage, and it has already been largely graded and stabilized, so there would be a minimum of disturbance to the floodplain.



Source: Q240.1R-6

Figure A2.2 Proposed CRBRP site, 100-year floodplain



Source: ER Response to Q240.1-R-6

Figure A2.3 Proposed CRBRP barge-unloading facility,
100-year floodplain

Construction of the plant would neither increase runoff to nor constrict flow in the Clinch River significantly. None of the plant features located in the floodplain would increase floodflows or change the flood level measurably. Furthermore, there do not appear to be reasonable alternatives to these features which, by necessity, must be located adjacent to or in the Clinch River.

The staff therefore concludes that the plant construction in the floodplain will not have a significant adverse effect on the river and is consistent with the guidance of Executive Order 11988.

Additionally, safety-related components of the plant are designed and will be constructed for protection against all possible flooding conditions including the probable maximum flood (PMF) and the design-basis flood level that results from the postulated seismic failure of Norris Dam, a flood considerably more severe than that addressed by the Executive Order.

2.6 Meteorology

Meteorological data regarding the site have been updated.

On 30 to 46 days annually, temperatures may be expected to reach 90°F or higher.

A maximum 24-hr total of 7.75 in. of precipitation was recorded at the X-10 station site (ER Sec 2.6.2.4), and a maximum 24-hr snowfall total of 12 in. was recorded at Oak Ridge. Data indicate that heavy fog (visibility 0.25 mile or less) occurs on about 34 days annually at the weather office location. Such occurrences may be more frequent at the proposed plant site, which is nearer the river. Wind speed and direction distributions (wind roses), based on February 17, 1977 to February 16, 1978 data collected on site at the 33- and 200-ft above-ground levels, are presented in Figure A2.4 (ER Figs 2.6-4 and -9). Onsite data used in determining the dispersion factors for radiological dose assessments (Section 5.7) were collected during the period from February 17, 1977 to February 17, 1978 (Section 6.1.3). These new data are considered to be the best collected and do not deviate markedly from earlier data.

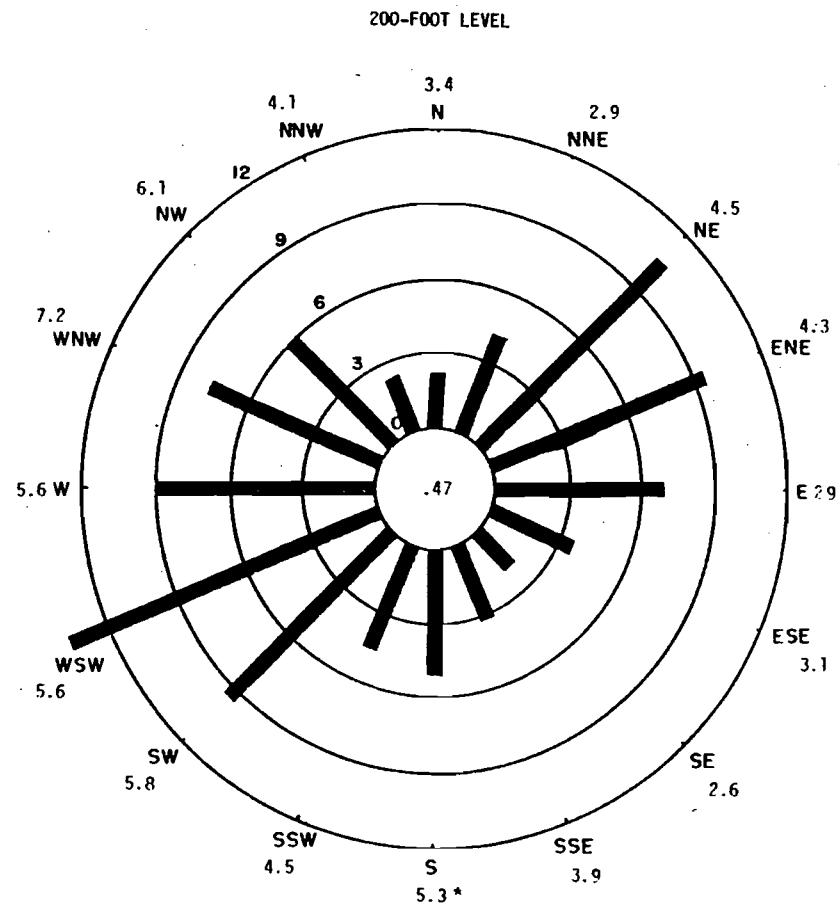
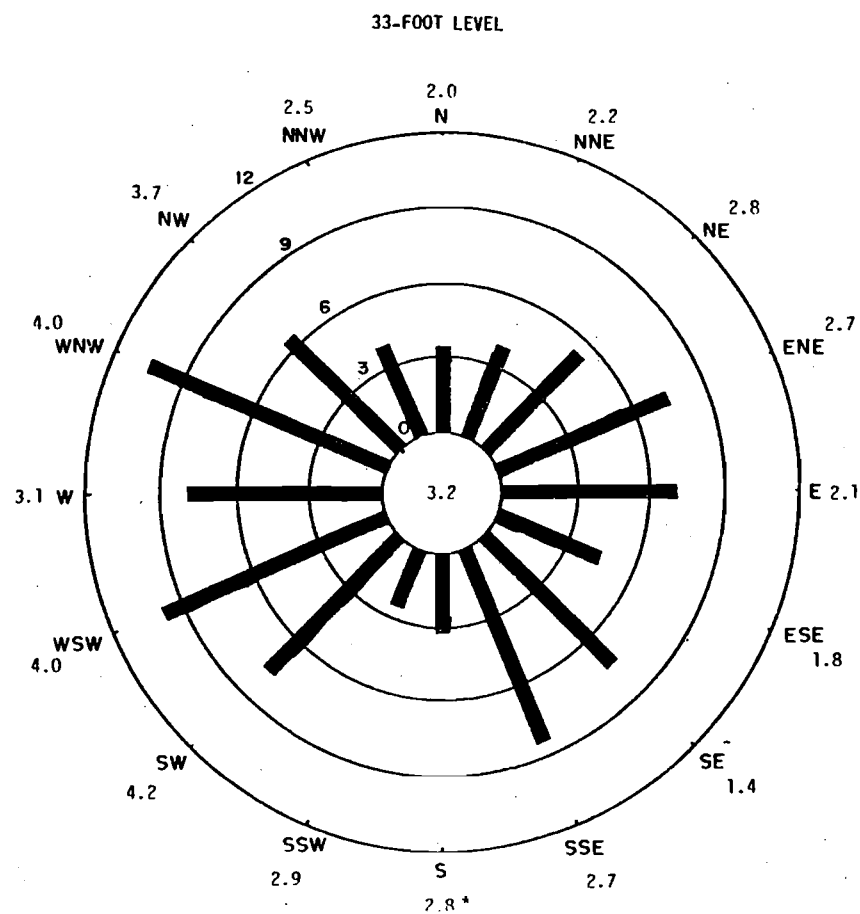
Footnote (a) of Table 2.3 in the FES should now read "Source: ER, Tables 2.6-4 and 2.6-24."

2.7 Ecology

2.7.1 Terrestrial Ecology

2.7.1.1 Flora

Cimicifuga rubifolia and Saxifraga careyana are the only plant species known to be on the proposed CRBRP site that may at some time in the future be listed as threatened or endangered, according to the U.S. Fish and Wildlife Service (see Appendix B; see also Section 4.4 for a discussion of impacts).



*Value denotes average wind speed for each sector (miles per hour).

Figure A2.4 Annual wind roses from CRBRP permanent meteorological tower data for February 17, 1977 through February 16, 1978 (replaces FES Fig. 2.9)

2.7.1.2 Fauna

2.7.1.2.1 Mammals

(2) Furbearers

In addition to those mammals discussed in the FES, bobcats have been observed several times on the Oak Ridge reservation.

(3) Threatened Species

The only mammal now listed as endangered that might occur on the proposed site is the gray bat (Myotis grisescens; see Appendix B), but to date feeding individuals have not been found on the site nor on the Oak Ridge reservation (ER Sec 2.7.1.4.1). Caves currently utilized by the grey bat for hibernating and for maternity are within 1 week's travel time of the site. Therefore, the grey bat could, on occasion, utilize the Clinch River in the vicinity of the site as feeding habitat. However, the staff concludes that construction and operation activities at Clinch River would not result in significant deterioration of potential feeding habitat (i.e., insects) along the Clinch River and, therefore, construction and operation activities would not affect the grey bat.

2.7.1.2.2 Birds

Of the 125 bird species observed on the site, only the bald eagle (Haliaeetus leucocephalus) is on the Federal list of endangered species and considered endangered by the State of Tennessee (see Appendix B). In addition, four other bird species considered by the state to be threatened and/or endangered have been observed: the sharp-shinned hawk (Accipiter striatus), Cooper's hawk (Accipiter cooperii), marsh hawk (Circus cyaneus), and the American osprey. All five rare species are on the Oak Ridge Reservation (ER Table 2.7-15). No nesting activities of these five species have been observed on the CRBRP site.

2.7.2 Aquatic Ecology

This material has been rewritten to aid reader understanding and to provide updated information.

Water quality is similar to that of southeastern U.S. rivers (Geraghty et al., 1973). Total and fecal coliform counts taken in the tailraces of Norris and Melton Hill Dams in 1967 (Section 2.5) are below the maximum allowable limit of 5000/100 ml MPN (most probable number) for any one water sample required by the State of Tennessee (TWQCB, 1973) for the protection of fish and aquatic life. Surface water samples in the vicinity of the proposed site were collected at three locations in the Clinch River nine times during 1974-75. The water samples were analyzed for standard plate, total coliform, fecal coliform, and fecal streptococcus. Maximum values for all counts were observed during March; this was probably attributable to bacterial runoff from land as a result of heavy rain just before the sampling. Fecal coliform and total coliform MPN/100 ml ranged from <4 to 1000 and <5 to 2300, respectively.

The phytoplankton community was sampled for the CRBRP from March 1974 through April 1975 and is represented by 157 species. The diatoms (Chrysophyta) were

the most numerous taxon from March through May; the percent abundance decreased in June and July and increased during August and September. The blue-green algae (Cyanophyta) were present in May; the percent abundance increased in June and July, when they became the most dominant taxon, and decreased in August and September. The green algae (Chlorophyta) were a small percentage of the total number of organisms from May through July and increased significantly in August and September. Two other divisions of phytoplankton--euglenoids (Euglenophyta) and dinoflagellates (Pyrrophyta)--were present but in relatively low numbers. From May to January all five phytoplankton divisions were present. Phytoplankton densities ranged from 190 to 2940 cells/ml in the range given for TVA water bodies (Taylor, 1971). Diversity indices (Shannon-Wiener) were not significantly different among stations and sampling periods. Mean chlorophyll a concentration for June through April was 3.6 mg/m³ and ranged from 2.2 to 6.0 mg/m³, typical of TVA water bodies (ibid). A mean ratio of 1.4 to 1 was determined for the pheophytin a content of phytoplankton. Pheophytin a is the natural degradation product of chlorophyll a. The ratio of pheophytin a to chlorophyll a is the ratio of optical densities before and after acidifying the pigment extract. A ratio of 1.0 to 1 indicates the presence of only pheophytin a, whereas a ratio of 1.7 to 1 indicates that the samples are free of pheophytin a (EPA, 1973). Because a mean ratio of 1.35 to 1 is midway between 1.0 and 1.7, the phytoplankton population can be considered to consist of both decaying and nondecaying individuals.

The 1975 study conducted by Exxon Nuclear Company (Exxon, 1976) just downstream of the proposed CRBRP site revealed a dominance of Chrysophytes during the growing season from April through October. Both the CRBRP study and the Exxon Nuclear study described a single midsummer peak in abundance of phytoplankton. An Oak Ridge study (Loar and Burkhart, 1981), also downstream of the site, conducted in 1977-78, observed two pulses or peaks in phytoplankton abundance, one in late spring and one in early fall. Differences in sampling frequency, collection methodology, preservation, and analysis make detailed comparisons of the three studies impossible; however, it can be concluded that the phytoplankton community--its abundance and its annual succession--is typical of a Tennessee riverine situation.

A total of 81 zooplankton species were identified from the Clinch River at the site from March 1974 through April 1975, of which 57 species were rotifers and 24 arthropods. The arthropods consisted mainly of cladocerans and copepods. The number of zooplankters ranged from 1/liter to 206/liter. Highest densities were recorded in May, with lowest densities occurring in March. Seasonal variations in the Clinch River zooplankton are as follows: rotifers dominate numerically during early spring and summer, but decrease during the colder months; cladocerans are abundant from March through October; copepods are present throughout most of the year, even though not abundant, except possibly during the warmer months (ER Sec 2.7.2.4.3). Diversity indices were not significantly different between stations, but June-September mean diversity indices were higher than those for March or May. Some vertical stratification does occur among the rotifer species, but little occurs among the arthropod species. In September and November rotifers were up to three times more abundant in the surface samples than in the bottom samples.

Between 1973 and 1978 three additional surveys on zooplankton were conducted on the Clinch River in the vicinity of the proposed site; they are summarized in

Loar and Burkhart (1981). Considerable variability between studies in zooplankton abundance was reported; it is possibly the result of differences in sampling methodology, discharge regime, or natural variability.

Periphyton (attached algae) samples were collected from March 1974 through May 1975, with 149 species present, representing 5 phyla. Diatoms were the most numerous periphyton organisms, with blue-green algae, green algae, dinoflagellates, and euglenoids in decreasing order of abundance. The mean number of algal cells (no./cm²) ranged from 1.1×10^5 to 3.9×10^6 . Diversity indices showed no apparent differences between stations or seasons. The seasonal pattern of abundance is typical for these organisms. Diatoms had high densities in spring and lower densities in October. During the fall and winter blue-green algae decreased as expected. Diatoms were the numerically dominant form in the winter months, with blue-greens and greens present in lesser amounts. Mean values of chlorophyll a ranged from 8.4 to 55.8 mg/m² for the period between May 1974 and May 1975. The mean value for pheophytin a for all samples analyzed was 1.6, indicating a nondecaying photosynthetically active community.

Both the Exxon Nuclear study (Exxon, 1976) and the Oak Ridge study (Loar and Burkhart, 1981) reported similar successional patterns of abundance and dominance consisting of diatom-dominated communities during the winter and spring and a shift towards dominance by green and blue-green algae in summer and early fall.

Few aquatic macrophytes were found in the vicinity of the site during the baseline survey. A few strands of Eurasian water milfoil were collected, but their origin could not be identified. Also occasional growths of bryophytes and liverworts were encountered in the late spring and summer. The sparse growth of macrophytes is attributed to limited light penetration in the water, steep shorelines, fluctuating river water levels, and changing current velocities (ER Sec 2.7.2.4.6). In August 1980, macrophyte growth was observed to be more extensive than during the baseline period (ER Sec 2.7.2.5). During the Oak Ridge Survey in 1977-78, several small beds of Potamogeton were observed along the banks of the river at CRM 15.

Benthic macroinvertebrates (benthos) collected by dredging during the baseline study included the mollusks, annelids, flatworms, and insects. Insects, primarily midge larvae (Chironomide), were the dominant group in terms of total number of species collected, while mollusks--almost exclusively the Asiatic clam (Corbicula sp.)--were the dominant group in terms of total numbers of organisms and biomass.

Approximately 80 taxa were collected from the Clinch River between March 1974 through May 1975. Densities of benthic organisms ranged from 75 organisms/m² in March 1974 to 784 in April 1975. Diversity indices reflected the low diversity of benthic macroinvertebrates in the vicinity of the site. Several collections consisted entirely of Corbicula sp. Substrate type is a significant factor affecting benthos distribution (EPA, 1973). Three types of substrates--fine sand, sand, and gravels--were identified for the Clinch River near the site. Annelids, mainly Limnodrilus, were the dominant form in the sediments, with the mollusk Corbicula sp. and the coelenterate hydra dominant in the coarse sand and gravel, respectively. Biomass, expressed as composite

biomass and ash-free dry weight, was estimated for samples with clams (shell included) and samples without clams. Biomass of the samples ranged from 2 to 11,400 mg/m² with the clams and 0 to 165 mg/m² without the clams.

Although the most abundant benthic macroinvertebrate collected during the survey was Corbicula sp., with densities ranging from about 20 to 500 organisms/m², such densities are low in comparison with other stretches of the Tennessee system and elsewhere where densities as high as 65,000/m² have been reported (Sinclair, 1970). The relatively low density of Corbicula sp. in the vicinity of the site is primarily the result of the hardpan substrate, deep water, and cold release from Melton Hill Dam. Higher densities are known to occur in the overbank area upstream of the site (Copeland, 1981) and are expected to produce large numbers of larvae in the vicinity of the site.

Artificial substrates were also used to assess the macroinvertebrates. Chironomid larvae represented more than 50 percent of the 67 species identified. Biomass values ranged from 39 to 1260 mg/m². Mean biomass increased throughout the summer to September, decreased to a low in January, and then increased in the spring. The Asiatic clam was the dominant macroinvertebrate collected in terms of biomass. (For more detailed biomass values, lengths, and life history of this taxon, refer to ER Sec 2.7.2.4.5.)

Morton (1978), under contract with Exxon Nuclear, reported on the results of a benthic macroinvertebrate study just downstream of the proposed CRBRP site. He found a similar distribution and abundance of organisms, with the most frequent numerically dominant organism being Corbicula sp. and the greatest number of taxa in the Chironomidae. Morton concluded that benthic macroinvertebrates are limited in this region principally by the rapid fluctuation in the flow volume as a result of the operation of Melton Hill reservoir and the attendant decrease in habitable area.

Benthic macroinvertebrate communities in the Clinch River, in the vicinity of the Oak Ridge Gaseous Diffusion Plant, were sampled during 1977-78 between CRM 10.5 and 15 (Sasson, 1981). Fewer taxa were taken during the course of this study than reported by Morton (1978) and the applicants (ER Sec 2.7.2.4.5). Distribution and abundance of the dominant species, however, were similar to the earlier two studies.

Fletcher (1977) provided a check list of 76 species of fish known from the Clinch River in the vicinity of the site. The applicants reported (ER Sec 2.7.2.4.7) 34 species of fish collected from the Clinch River by electroshocking and gill netting from March 1974 through January 1975. Fletcher, using the same gear in monthly sampling from May 1975 through April 1976, reported 50 species of fish collected from the Clinch River below Melton Hill Dam. Loar et al. (1981) and Loar (1981), also using the same gear in 1977-80, reported 29 species from the Clinch River above and below the proposed CRBRP site. A composite list of species from these studies is presented in Table A2.2.

Sampling conducted by the applicants in 1974-75 revealed that gizzard and threadfin shad were the numerically dominant species and accounted for 45% of the total catch. The skipjack herring comprised 15% of the weight of the total catch and represented the greatest biomass of any species. The same dominance in number of specimens taken was found by Fletcher (1977); however, sauger, carp,

Table A2.2 Fish species taken from the Clinch River
below Melton Hill Dam in the vicinity
of the proposed CRBRP Site

Scientific name	Common name
Family - Polyodontidae	
<u>Polyodon spathula</u>	Paddlefish
Family - Lepisosteidae	
<u>Lepisosteus oculatus</u>	Spotted gar
<u>Lepisosteus osseus</u>	Longnose gar
Family - Clupeidae	
<u>Alosa chrysochloris</u>	Skipjack herring
<u>Dorosoma cepedianum</u>	Gizzard shad
<u>Dorosoma petenense</u>	Threadfin shad
Family - Hiodontidae	
<u>Hiodon tergisus</u>	Mooneye
Family - Cyprinidae	
<u>Cyprinus carpio</u>	Carp
<u>Hybopsis storeriana</u>	Silver chub
<u>Notemigonus crysoleucas</u>	Golden shiner
<u>Notropis ardens</u>	Rosefin shiner
<u>Notropis atherinoides</u>	Emerald shiner
<u>Notropis spilopterus</u>	Spotfin shiner
<u>Pimephales notatus</u>	Bluntnose minnow
<u>Pimephales vigilax</u>	Bullhead minnow
Family - Catostomidae	
<u>Carpiodes carpio</u>	River carpsucker
<u>Carpiodes cyprinus</u>	Quillback carpsucker
<u>Catostomus commersoni</u>	White sucker
<u>Hypentelium nigricans</u>	Northern hog sucker
<u>Ictiobus bubalus</u>	Smallmouth buffalo
<u>Ictiobus cyprinellus</u>	Bigmouth buffalo
<u>Ictiobus niger</u>	Black buffalo
<u>Minytrema melanops</u>	Spotted sucker
<u>Moxostoma anisurum</u>	Silver redhorse
<u>Moxostoma carinatum</u>	River redhorse
<u>Moxostoma duquesnei</u>	Black redhorse
<u>Moxostoma erythrurum</u>	Golden redhorse
Family - Ictaluridae	
<u>Ictalurus punctatus</u>	Channel catfish
<u>Pylodictis olivaris</u>	Flathead catfish

Table A2.2 (Continued)

Scientific name	Common name
Family - Poeciliidae	
<u>Gambusia affinis</u>	Mosquitofish
Family - Percichthyidae	
<u>Morone chrysops</u>	White bass
<u>Morone mississippiensis</u>	Yellow bass
<u>Morone saxatilis</u>	Striped bass
Family - Atherinidae	
<u>Labidesthes sicculus</u>	Brook silverside
Family - Centrarchidae	
<u>Ambloplites rupestris</u>	Rock bass
<u>Lepomis auritus</u>	Redbreast sunfish
<u>Lepomis gulosus</u>	Warmouth
<u>Lepomis macrochirus</u>	Bluegill
<u>Lepomis megalotis</u>	Longear sunfish
<u>Lepomis microlophus</u>	Redear sunfish
<u>Micropterus dolomieu</u>	Smallmouth bass
<u>Micropterus punctulatus</u>	Spotted bass
<u>Micropterus salmoides</u>	Largemouth bass
<u>Pomoxis annularis</u>	White crappie
<u>Pomoxis nigromaculatus</u>	Black crappie
Family - Percidae	
<u>Etheostoma blennioides</u>	Greenside darter
<u>Etheostoma simoterum</u>	Tennessee snubnose darter
<u>Perca flavescens</u>	Yellow perch
<u>Percina caprodes</u>	Logperch
<u>Stizostedion canadense</u>	Sauger
<u>Stizostedion vitreum vitreum</u>	Walleye
Family - Sciaenidae	
<u>Aplodinotus grunniens</u>	Freshwater drum
Family - Cottidae	
<u>Cottus carolinae</u>	Banded sculpin

Sources: ER Section 2.7.2.4.7; Fletcher, 1977; Loar, 1981; and Loar et al., 1981.

and skipjack herring were the most dominant based on biomass, each comprising approximately 20% of the total catch. Loar (1981) found in the 1977-80 Oak Ridge studies a high relative abundance of game fish that, in part, can be accounted for by the relatively low abundance of forage fishes.

The applicants found in the 1974-75 study that approximately the same number of fish were collected from stations on opposite sides of the river, except at sampling transects in the vicinity of Poplar Springs Creek and Caney Creek, where approximately twice as many fish were collected near the mouth of the creeks. The applicants categorized the species of fish collected into one of three categories: rough, forage, and game fishes. The rough fish (so-called commercial fish) comprised about 21% of the catch by numbers of specimens and 61% of the catch by weight. Forage fish accounted for 63% numerically and 22% by weight of the total catch, and game species 16 and 17%, respectively.

The 1978 commercial fish catch in Watts Bar Reservoir for all species was about 389,000 lbs, with a commercial value of about \$116,700. Additionally 1000 lbs of paddlefish roe were taken, worth approximately \$24,000 (Tomljanovich, 1981). After 1978, Watts Bar Lake was closed to gill and trammel nets by the Tennessee Wildlife Resources Agency (TWRA), primarily to protect the striped bass sports fishery. As a result, the commercial buffalo fishery declined. The 1980 commercial harvest estimate for all species was 260,000 lbs, valued at \$78,000, and 1000 lbs of paddlefish roe, valued at \$35,000. Less than 1% of the total catch for Watts Bar Reservoir was harvested within a 10-mile radius of the site.

Based on creel censuses conducted by TWRA, the 1979-80 recreational harvest from Watts Bar Reservoir was estimated at about 280,000 fish and 200,000 lbs. Information on the sport fishing around the site is limited. It is primarily a sauger fishery in the winter, with white bass, crappie, and Micropterus sp. sought after in the spring. Some fishing for striped bass occurs in late summer (Masnik, 1982a). During the baseline monitoring program, approximately 280 hours were spent on the Clinch River near the proposed site collecting samples, and fewer than 10 fishing parties were observed. According to TVA biologists, the best fishing in the area is in the tailwaters of Melton Hill Dam, approximately 6 miles upstream of the site (ER Am I Part II, C3).

Ichthyoplankton (fish eggs and larvae) were sampled by the applicants in 1974. Approximately 300 unidentified fish eggs were collected, with 93% of the eggs collected on May 16 and June 23, 1974. Fourteen larvae were also collected and identified as to family (1 Percidae and 13 Clupeidae). Fletcher (1977) collected larval fish at CRM 12, 14.4, and 15 in 1975. A total of 2328 larvae were taken. Clupeidae were the dominant taxon, comprising 90% of the total number and 76% of the total weight. White crappie larvae represented 9% of the total number and 18% of the total weight and were the second most abundant larval fish. Other species of larvae taken during this study were carp, shiner, bluntnose minnows, Moxostoma sp., channel catfish, brook silverside, Lepomis sp., and Micropterus sp. Cada and Loar (1981) collected 4198 fish eggs and 38,443 larvae in 1978 from Poplar Creek and the Clinch River just downstream of the proposed site. Clupeids comprised 92.9% of the total larvae collected, with Morone sp. also relatively common. Loar et al. (1981) reported clupeids as the most abundant ichthyoplankton from CRM 19 and 22, reaching peak densities in June and July.

Sauger may use the region of the river bordering the site for spawning. In April 1976 at CRM 12, 14.4, and 15, Fletcher (1977) found running males and gravid females in gill net samples, indicating possible capture during the act of spawning.

A single Stizostedion sp. larvae was taken at CRM 15-18 on March 28, 1974 (Fletcher, 1977). Two additional Stizostedion sp. larvae were taken near the Kingston Steam Plant in 1975, the first on April 9 and the second on April 23 (TVA, 1976, in Fletcher, 1977). One post-larval Stizostedion sp. was taken on April 9, 1976 at CRM 12 (Fletcher, 1977). In 1979, TVA conducted (Scott, 1980) a study in the Clinch River below Melton Hill Dam to investigate the hypothesis alluded to by Fletcher (1977) that sauger do not utilize the tailwaters of the dam for spawning but rather use the lower reaches of the river. Gill nets were fished for a 7-week period during the spring. Peak spawning activity based on a catch/net-night ratio and the number of flowing females occurred from April 10 to April 25. The results of the study indicate that the area immediately below the dam is not used for sauger spawning but rather that spawning occurs 6 to 8 miles downstream. It appeared that spawning was not localized in a small area because areas with high spawning activity one week did not show the same activity the next. The highest catch rates reported by the study were immediately below the proposed discharge structure in the vicinity of the submerged island. Most fish were taken in the deeper half of the gill net, with many at the end and taken over sand and silt substrate.

In the spring of 1982, TVA biologists conducted further studies to determine the extent and location of sauger spawning in the vicinity of the site. Greatest concentrations of adults (based on gill net samples) were found at CRM 16.0 and 16.8. A single, ripe running female was collected at both CRM 16.0 and CRM 19.5. The study concluded that sauger spawning is mostly confined to the stretch of river between Gallaher Bridge and Melton Hill Dam.

Stomach content analysis was performed on the seven most abundant fish species present from March through January 1975. ER Table 2.7-100 classifies the individual fish species whose stomachs contained food groups. The major food items varied with fish species but included fish, zooplankton, benthic invertebrates, aquatic insects, detritus, and bottom material.

In 1964 the Tennessee Wildlife Resources Agency began a yearly stocking program in Watts Bar Lake for striped bass that has been continued to the present. The striped bass is considered a cool water species and water temperature affects its habits and distribution. A substantial striped bass recreational fishery has not developed in Watts Bar Lake, and the adults of this species are thought to be limited by high water temperatures and low dissolved oxygen levels present in the lake during late summer and early fall. Lakes without temperatures below about 22°C in well-oxygenated zones have been found unsuitable for adult striped bass larger than about 5 kg (Coutant, 1982). In Cherokee Reservoir, Tennessee, the higher summer ambient water temperatures and low dissolved oxygen levels limit for striped bass the habitable volume of the reservoir to several small thermal refuges and apparently have contributed to massive die-offs of adults larger than 4-5 kg (8-10 lbs) (ibid).

Maximum water temperatures in Watts Bar Lake during August and September 1980 ranged from 25.5°C at the bottom to 29.5°C at the surface (Cheek, 1982). Cheek (1982) found that as the main body of Watts Bar Lake warmed up fish began to

move into thermal refuges. No striped bass were found in the main body of the reservoir when water temperatures reached 24° to 25°C. Cheek (1982) found three thermal refuges for adult striped bass in Watts Bar Lake: a groundwater source in the Tennessee River arm of the reservoir, the tailwaters of Tellico Dam (no longer a refuge after its closure in September 1979), and the Clinch River below Melton Hill Dam between CRM 13.5 and 22. The discharge for the CRBRP is planned at CRM 16.5.

In the Clinch River, the favored locations of striped bass during late summer and early fall are thought to be the outside of the river bend from approximately CRM 15 to CRM 17 and the western side of the river near Grubb Islands, from approximately CRM 18 to CRM 18.5 (ER Sec 2.7.2.5). Cheek (1982) found the fish primarily along the banks in the shallows where the shoreline was steep and exposed to the water current with many overhanging or immersed trees and logs creating slack water and eddies. It is thought that a significant portion, perhaps the major portion, of adult striped bass inhabiting Watts Bar Lake utilize the Clinch River in the vicinity of the proposed CRBRP site during periods of high thermal stress in the main reservoir.

The U.S. Fish and Wildlife Service has notified the NRC (Hickling, 1981) that 11 species of freshwater mussels from the family Unionidae and 1 species of fish from the family Cyprinidae, which are Federally listed as threatened or endangered, may be present at the proposed CRBRP site or vicinity (see Section 5.3.4). Sampling before 1982 conducted or contracted by TVA, PMC, TWRA, Exxon Nuclear, and Oak Ridge National Lab did not reveal the presence of any of these species from the Clinch River in the vicinity of the proposed facility. In April 1982, while sampling for sauger eggs, TVA biologists found a single live specimen of the Federally protected Lampsilis orbiculata orbiculata, the pink mucket pearly mussel. This specimen was collected at CRM 19.1, about 1 mile upstream of the proposed site.

In May 1982, TVA conducted an intensive mussel survey of the Clinch River in the vicinity of the proposed site. Transects every 0.2 mile from CRM 14.0 to CRM 21.0 were established. Teams of divers traversed the transects and collected mussels from the river bottom. Area surveys were also conducted in the vicinity of the barge-unloading facility, intake, and discharge. A total of 189 specimens from 10 species of freshwater mussels were collected. No threatened or endangered species were taken. Although no Federally protected species of freshwater mussels were taken during the survey, the collection of the single specimen in April confirms that the species is present in the Clinch River in the vicinity of the site. Jenkinson (1982) estimated, based on extrapolation of the mussel survey, that within the 7-mile reach of river the population size of Lampsilis o. orbiculata is likely to be in the range of 1 to 211 individuals.

The Tennessee Wildlife Resources Commission has declared a number of species to be endangered or threatened (TWRC, 1975). The only species on the state list (which includes all the Federally recognized species) that is known to be in the vicinity of the site is the blue sucker, Cycleptus elongatus. It has been taken in Watts Bar Lake on three occasions (ER Sec 2.7.2.4.11). In 1975 one specimen was taken near the mouth of the Clinch River (CRM 0.3), and in 1977 one specimen was collected from the Tennessee River near Loudon, TN. On April 19, 1982, a specimen was taken at CRM 12.0 incidental to a sauger study by a TVA biologist. Additionally, one specimen was taken (Fitz, 1968) during the preimpoundment survey of Melton Hill Reservoir.

The above information is largely new, but much of it is merely cumulative; in either case the staff does not expect that there will be significant new or changed aquatic impacts from the CRBRP (Sections 4.4.2 and 5.3).

2.8 Social and Community Characteristics

Some changes in the social and community characteristics of the area have occurred, as discussed below.

The Oak Ridge Gaseous Diffusion Plant now employs about 5600 people. The Oak Ridge National Laboratory (ORNL) employs about 5100 people, and Y-12 about 6300 (ER, Sec 2.2.2.2).

The four counties (Anderson, Knox, Loudon, and Roane) that are expected to experience the bulk of the impact of constructing and operating the CRBR had a 1980 population 464,018; this population is expected to grow to 523,252 by 1990. Knoxville, with a 1980 population of 183,139, is by far the largest urban center in the four-county region and serves as the region's focal point.

The presence of DOE/contractor operations in Oak Ridge has had a significant impact on present day socioeconomic conditions. For instance, the percentage of professional and technical employees in Anderson and Knox Counties (26% and 16%, respectively) is much higher than in the state overall and reflects Oak Ridge employment. Increasingly, the residences of Oak Ridge employees are dispersed throughout the region. Approximately 25% of those working at Oak Ridge live in Knoxville. Employment at Oak Ridge has also raised the per capita income averages of Anderson and Knox Counties above those for the state and for Loudon and Roane Counties (ER Sec 8.1.2.2.2).

In the four-county area, more than 20% of the existing housing stock has been constructed since 1970. Despite the rapid expansion of the housing stock, the percentage of vacant units has remained low. For individual counties and municipalities the rates are as low or lower than those recorded in the 1970 U.S. census. With the exception of Roane County, single family units constitute the largest percentage of housing by type added during the 1970-1980 period. In Roane County, 50% of the new units were mobile homes. Mobile homes constituted less than 25% of the units added to the stock in Anderson and Loudon Counties during the 1970s (ER Sec 8.1.3.1).

Eight school systems serve the four-county area and, with the exception of the Knox and Anderson schools, were under capacity during the 1980-1981 school year. The schools in Oak Ridge, Roane, and Harriman have the largest differentials between capacity and current enrollment. As Table A2.3 indicates, the number of school age children is expected to decrease during the 1980-1990 decade, thereby providing additional capacity (ER Sec 8.1.3.1; see also Sec 4.5 of this document).

Most of the water supply systems in the four-county area are operating well below treatment capacity. Only two districts are operating at capacity, and both systems are able to purchase water from adjacent districts while additional plant capacity is being constructed (ER Sec 8.1.3.3). All wastewater utility districts are operating below treatment capacity except for the Harriman

Table A2.3 Current and projected population aged 5 to 19 years

County	1980	1985	1990
Anderson	15,385	13,745	13,550
Knox	72,949	69,264	72,568
Loudon	6,159	5,779	6,050
Roane	10,896	10,004	10,221
Total	105,389	98,792	102,289

Source: State of Tennessee,
Department of Public Health

district. Three districts with the lowest differentials between average daily flow and capacity have indicated plans to increase capacity by 1984 (ER Sec 8.1.3.3.2).

The current data presented above relative to socioeconomic considerations are essentially cumulative and do not deviate markedly from the trends anticipated in the FES (see Sections 4.1, 4.5, and 5.6 below for the staff's present assessments).

3 FACILITY DESCRIPTION

3.1 External Appearance

The concrete, dome-capped, cylindrical shell that encloses the reactor containment building, would rise 179 ft instead of 169 ft above the grade set for principal plant structures. The emergency cooling tower structure would now consist of two mechanical draft wet cooling towers, each about 36 ft high, 37 ft wide, and 88 ft long.

A conceptual architectural rendering of the plant (FES Fig. 3.1) and the building layout (FES Fig. 3.2) have been revised as shown in Figures A3.1 and A3.2.

In addition to previously described features, a 5-ft-high animal fence would be erected about 33 ft from the security fence. The exclusion area would include the full width of the river, touching the site property and the entire 1364-acre site except for the 112 acres in the Clinch River Consolidated Industrial Park (FES Fig. 3.3).

3.2 Reactor and Steam-Electric System

The homogeneous core design has been replaced by the heterogeneous arrangement described below and in ER Section 3.2.2.

The mixed-oxide fuel would be in the form of sintered pellets encapsulated in stainless steel rods. The plutonium enrichment (Pu/Pu + U) in the fuel would be 32-33%. The 14-in. long axial blanket sections above and below the 36-in. active middle section of each rod would contain depleted UO₂ pellets with 99.8% ²³⁸U and 0.2% ²³⁵U. Each of the 156 fuel assemblies (Figure A3.3) in the reactor core would have 217 of these fuel rods. Surrounding the core would be a radial blanket consisting of 126 assemblies, each with 61 rods containing depleted UO₂ pellets. In addition, 76 blanket assemblies and 6 alternate fuel/blanket assemblies would be arranged within the core boundary. Figure A3.3 shows a partial cross section of the reactor indicating how the fuel assemblies are positioned.

The refueling scheme calls for a complete replacement of all core assemblies every 2 years of operation. Midway in the 2-year cycle, six internal blanket assemblies will be replaced by fresh fuel assemblies to replace burnup. Row 1 of the outer blanket will be replaced by fresh blanket assemblies every 4 years, and Row 2 will be replaced similarly every 5 years.

During operation of the reactor, a portion of the fertile ²³⁸U in the axial and radial blankets would be converted to ²³⁹Pu. When conversion exceeds the consumption of fissile material in the core, that action is known as breeding. The applicants expect to achieve a breeding ratio of 1.29 to 1 with the initial core, and 1.24 to 1 with the equilibrium core (ER, Table 3.2-2).

The primary sodium coolant outlet temperature was incorrectly given as 999°F in the third paragraph of FES page 3-2; it should be 995°F.

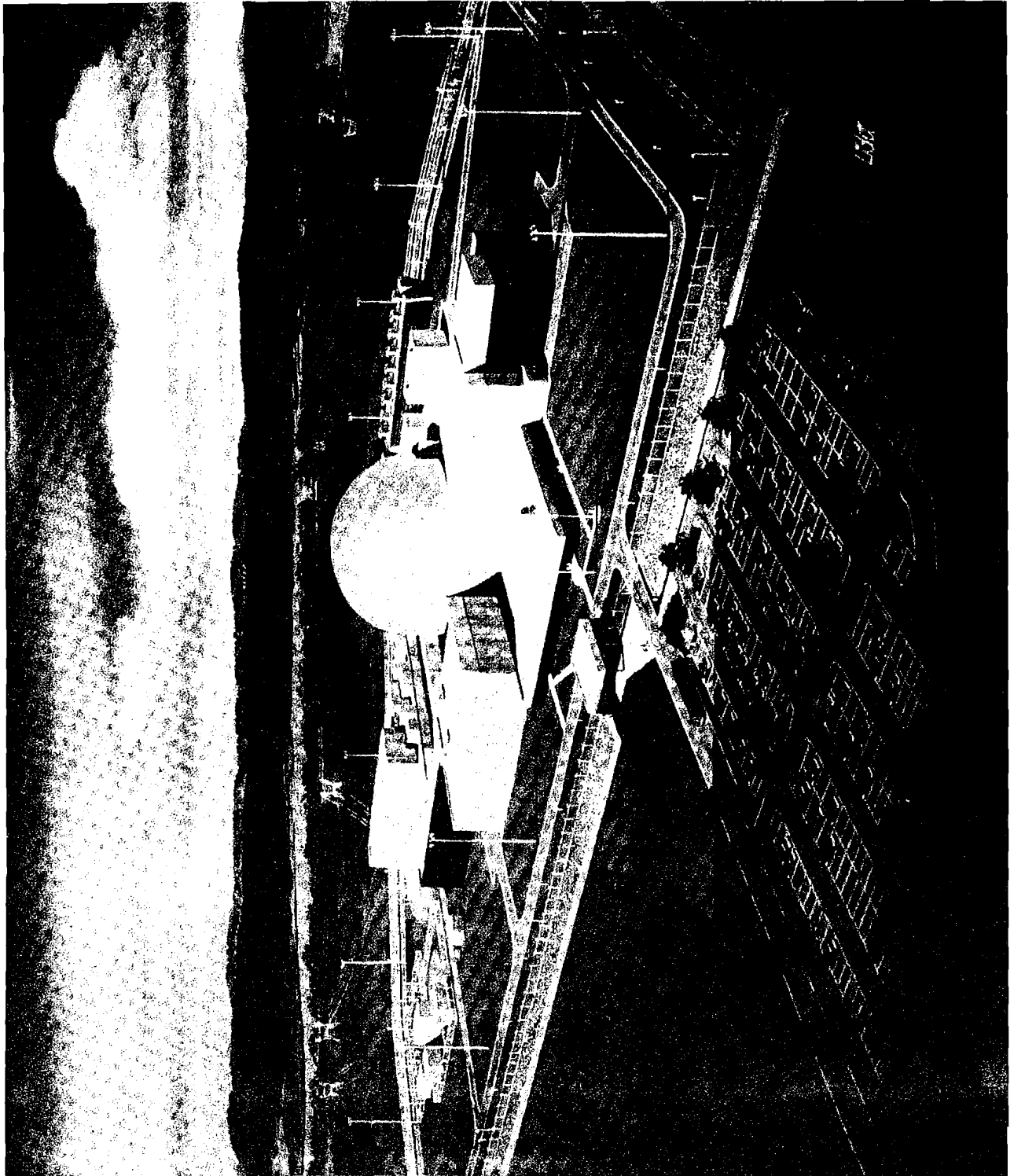
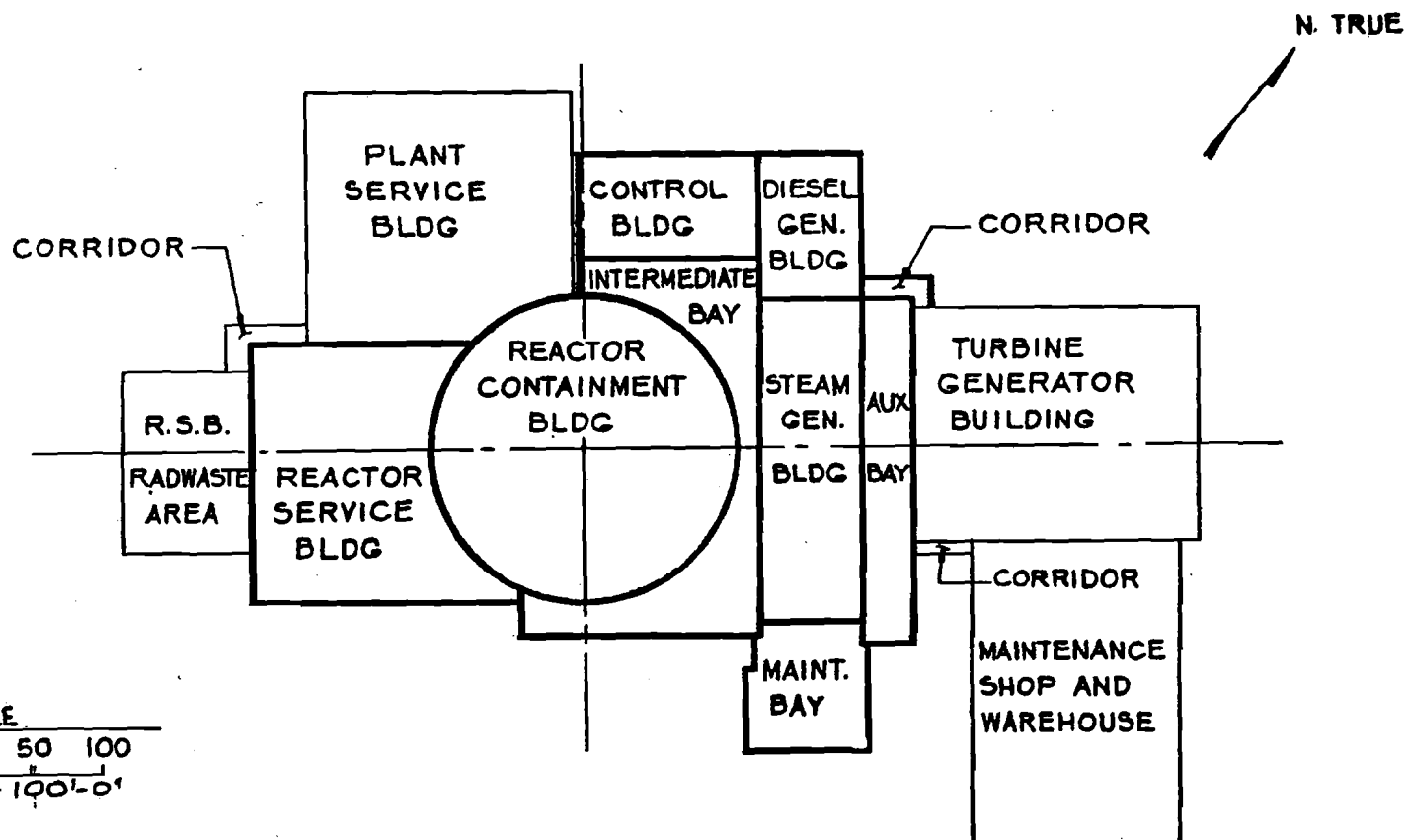
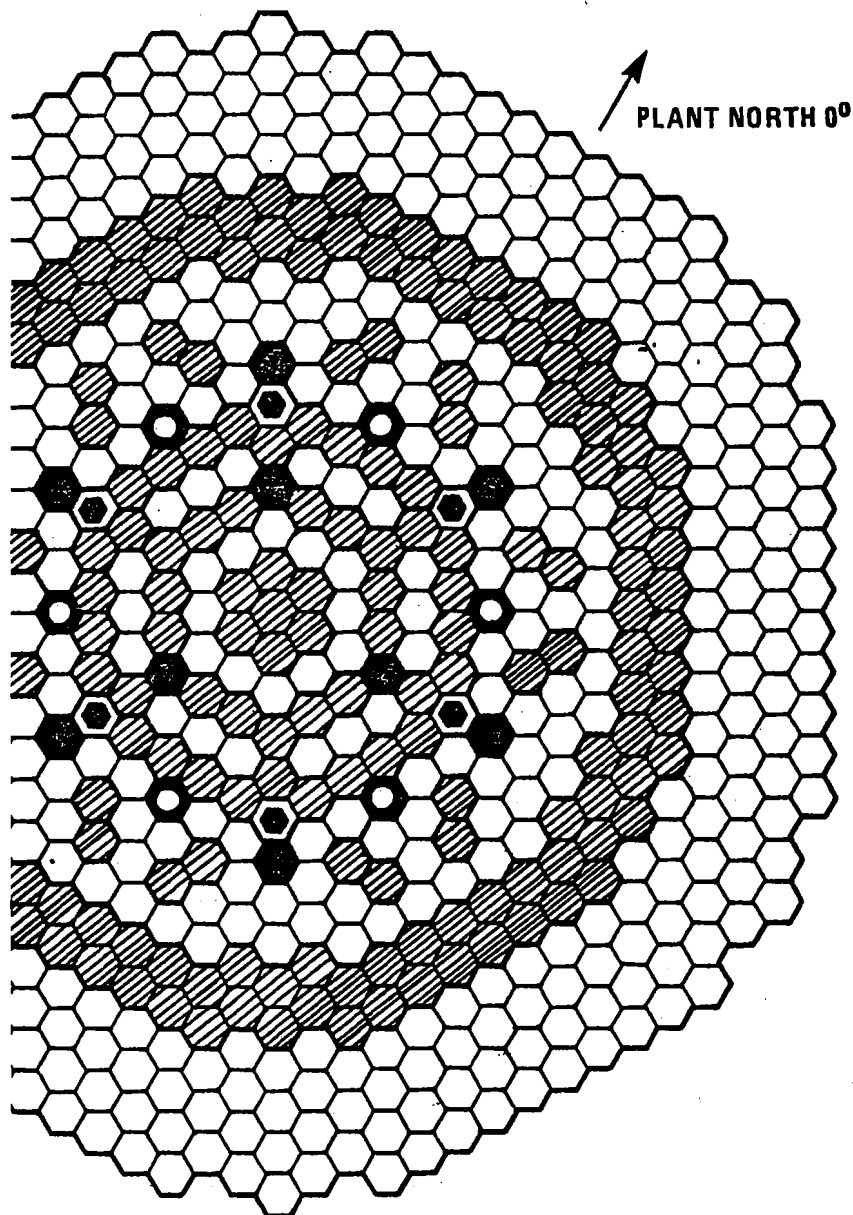
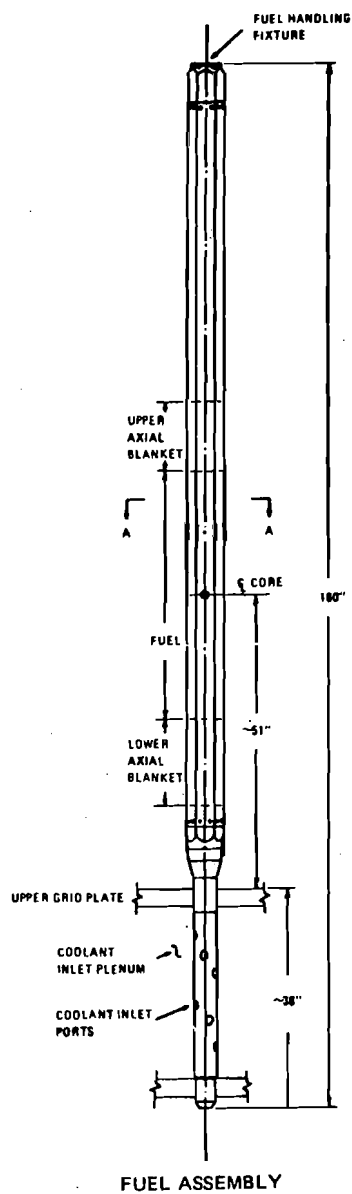


Figure A3.1 A conceptual architectural rendering of the CRBRP



NOTE: HEAVY LINES INDICATE CATEGORY I STRUCTURES

Figure A3.2 Main building layout of CRBRP



○ 156 FUEL ASSEMBLIES

▨ 76 INNER BLANKET ASSEMBLIES

▩ 126 RADIAL BLANKET ASSEMBLIES

● 6 ALTERNATE FUEL BLANKET ASSEMBLIES

⬤ 6 SECONDARY CONTROL ASSEMBLIES

312 RADIAL SHIELD ASSEMBLIES

⬤ 9 PRIMARY CONTROL ASSEMBLIES

Figure A3.3 CRBRP heterogeneous core design

3.3 Water Requirements

Water use rates have been revised. For maximum power, the anticipated annual average water makeup requirement has increased from 13 cfs (5835 gpm) to 13.6 cfs (6109 gpm), and estimated total consumptive use of river water has increased from 3584 gpm to 3677 gpm. An average of 5.4 cfs (2432 gpm) would be returned to the river as blowdown (2326 gpm) and effluent from other plant systems (106 gpm). Approximately 8.3 cfs (3730 gpm) would be consumed through evaporation, drift, and plant water usage. Figure A3.4 is a water usage flow diagram for the plant. The greatest consumptive water use, representing about 0.15% percent of the river's annual average flow rate, would take place in the heat dissipation system.

3.4 Heat Dissipation System

3.4.1 Cooling System

During maximum power operation, the cooling water flow rate to the mechanical draft cooling towers would be 212,200 gpm instead of the 185,200 gpm shown in the FES. The heat rejection from each cooling tower has increased from 2.17×10^9 to 2.26×10^9 Btu/hr.

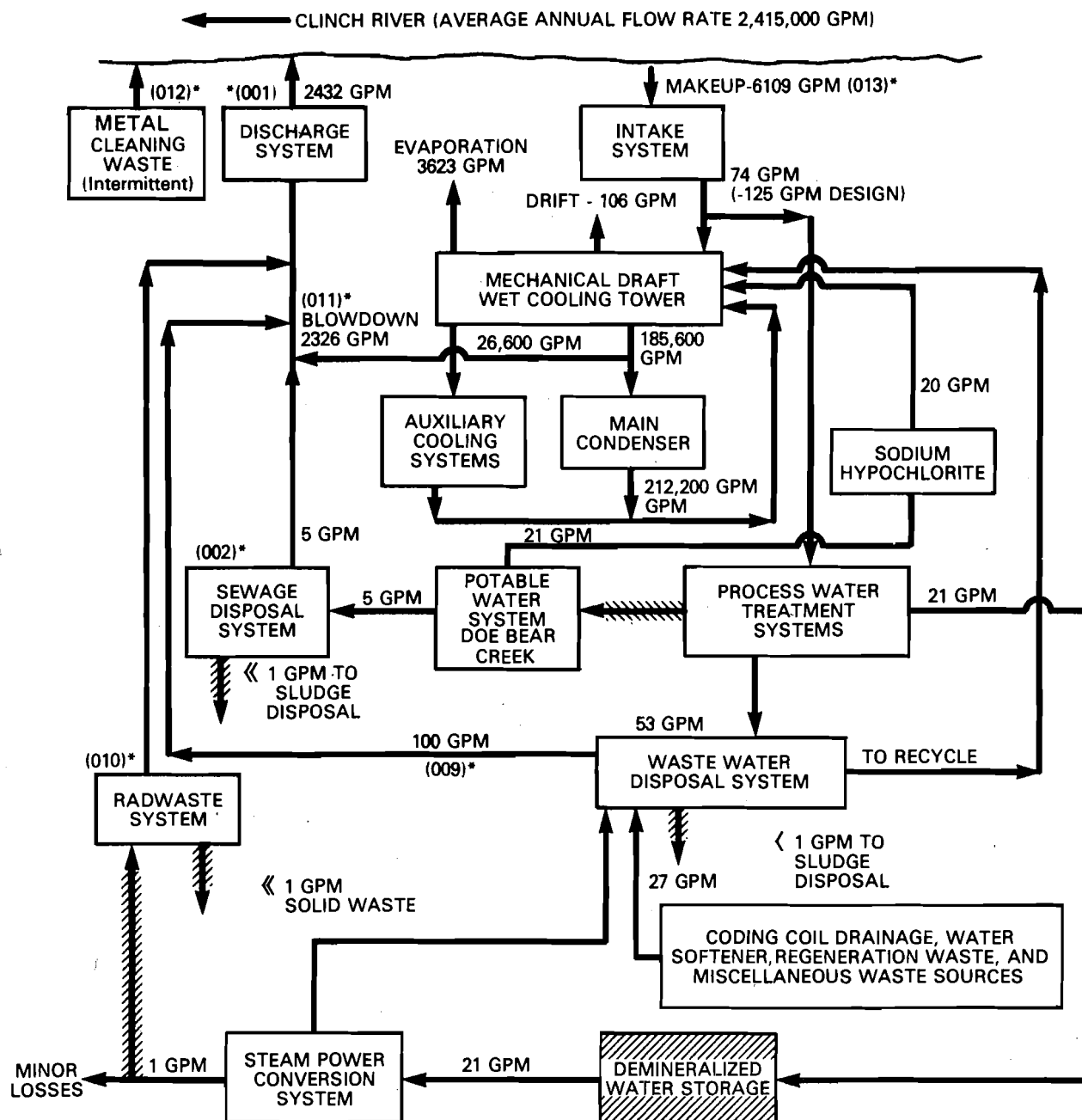
The expected monthly operating conditions and cooling tower performance characteristics are listed in Table A3.1 (ER Table 3.4-4). The figures for the cooling tower blowdown have been revised from those given in the FES. The daily maximum cooling tower blowdown temperature is limited to 91°F in the draft NPDES Permit rather than 90.5°F. The minimum expected temperature is now 60.5°F instead of 61.5°F.

Table A3.1 Water temperatures of the Clinch River
and the cooling tower blowdown, °F

	River water*			Mechanical wet cooling tower blowdown		
	Avg	Avg max	Avg min	Avg	Daily max	Daily min
Jan	42.7	48.0	37.9	66.3	69.0	60.5
Feb	42.1	48.0	37.6	67.5	69.2	60.5
Mar	47.0	54.9	40.9	70.5	72.0	63.0
Apr	55.1	62.3	48.1	75.0	77.5	66.5
May	60.9	66.4	56.0	79.5	83.0	71.0
Jun	63.5	69.9	58.5	85.0	88.5	75.5
Jul	64.4	69.4	60.3	86.5	91.0	78.0
Aug	65.7	70.1	61.9	86.0	90.0	77.2
Sep	66.9	70.4	63.4	83.0	87.5	73.7
Oct	64.6	68.7	60.2	76.0	81.0	68.5
Nov	57.0	63.4	50.4	70.5	73.0	63.0
Dec	47.7	53.8	43.0	67.0	69.0	60.5

Source: ER Table 3.4-4

*June 1963 to October 1972, Whitewing Bridge Temperature data from TVA.



NOTE: Cooling tower flowrates are annual averages at max. power operation

*NPDES SERIAL NUMBER

Figure A3.4 Average annual water use rates (replaces FES Fig. 3,6)

Figure A3.5 illustrates the relationship between the wet bulb temperature and the blowdown rate (ER Fig. 3.4-4); it replaces FES Figure 3.7. The auxiliary cooling water systems design has been changed to provide 27,000 gpm instead of 24,000 gpm at 95°F or less.

3.4.2 The Intake (NPDES 013)*

The description of the plant water intake has been modified and expanded. The top of the intake structure now will be 8.5 ft above river bottom rather than 8 ft (see Figure A3.6, which replaces FES Fig. 3.8).

Each of the two intake perforated pipes will be about 24-ft-long and consist of an outer pipe with 3/4-in.-diameter holes covering about 40% of the area and an inner diameter sleeve with larger diameter holes covering significantly less surface area. The outer sleeve is designed to minimize the numbers of fish and the amount of debris entering the system; the inner sleeve is designed to distribute the inflow evenly along the surface of the outer sleeve. Because of the low inlet velocity of 0.2 to 0.4 fps, the applicants anticipate no substantial accumulation of trash on the perforated pipe; therefore, trash racks and screens would not be necessary. Removal of impinged debris from the inlet pipe can be accomplished by flow reversal in the intake piping (ER Am I, Part II, C16).

Two 100% capacity river water pumps would be provided to supply makeup water to the cooling tower basin. The pump design flow rate of 2500 to 10,000 gpm has been changed to 2500 to 9000 gpm.

The above design changes do not result in significant changes in the staff's assessment.

3.4.3 The Discharge (NPDES 001)

A submerged single-port discharge structure as shown in FES Figure 3.12 would be constructed to dispose of the cooling tower blowdown and other plant liquid wastes. The total station discharge rate would be about 2412 gpm.

In FES Figure 3.12, the dimension of 29 ft across the top view should be 39 ft.

3.5 Radioactive Waste Systems

The staff's liquid and gaseous source terms were calculated by the PWR-GALE code, which is described in NUREG-0017, modified to apply to liquid metal fast breeder reactors. (In the FES, this document was identified as Draft Regulatory Guide 1.1BB). The principal parameters used in the source term calculations are given in FES Table 3.2. The radioactive argon processing system (RAPS) charcoal adsorber beds dynamic adsorption coefficients shown in the table do not apply because the applicants no longer plan to use those beds. The values for the cell atmosphere processing system (CAPS) charcoal adsorber beds dynamic adsorption coefficients were taken from "Adsorption Bed Performance Equations for Isothermal Steady State Systems" (Atomics International, 1973).

*NPDES number refers to the outfall serial number in the draft NPDES Permit or to special conditions included in Part III of the draft NPDES Permit (see Appendix H).

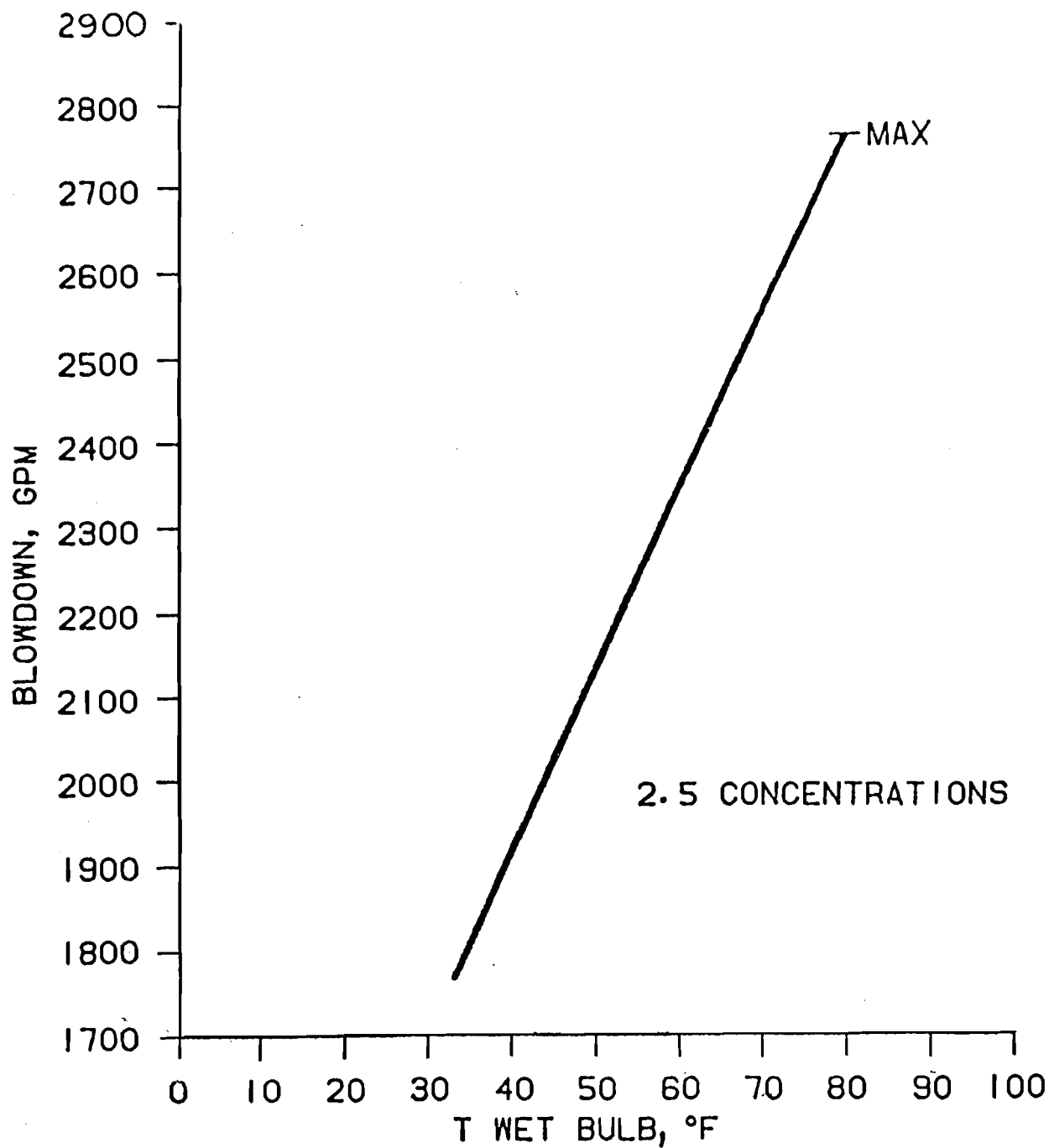


Figure A3.5 Mechanical draft wet tower blowdown
(replaces FES Fig. 3.7)

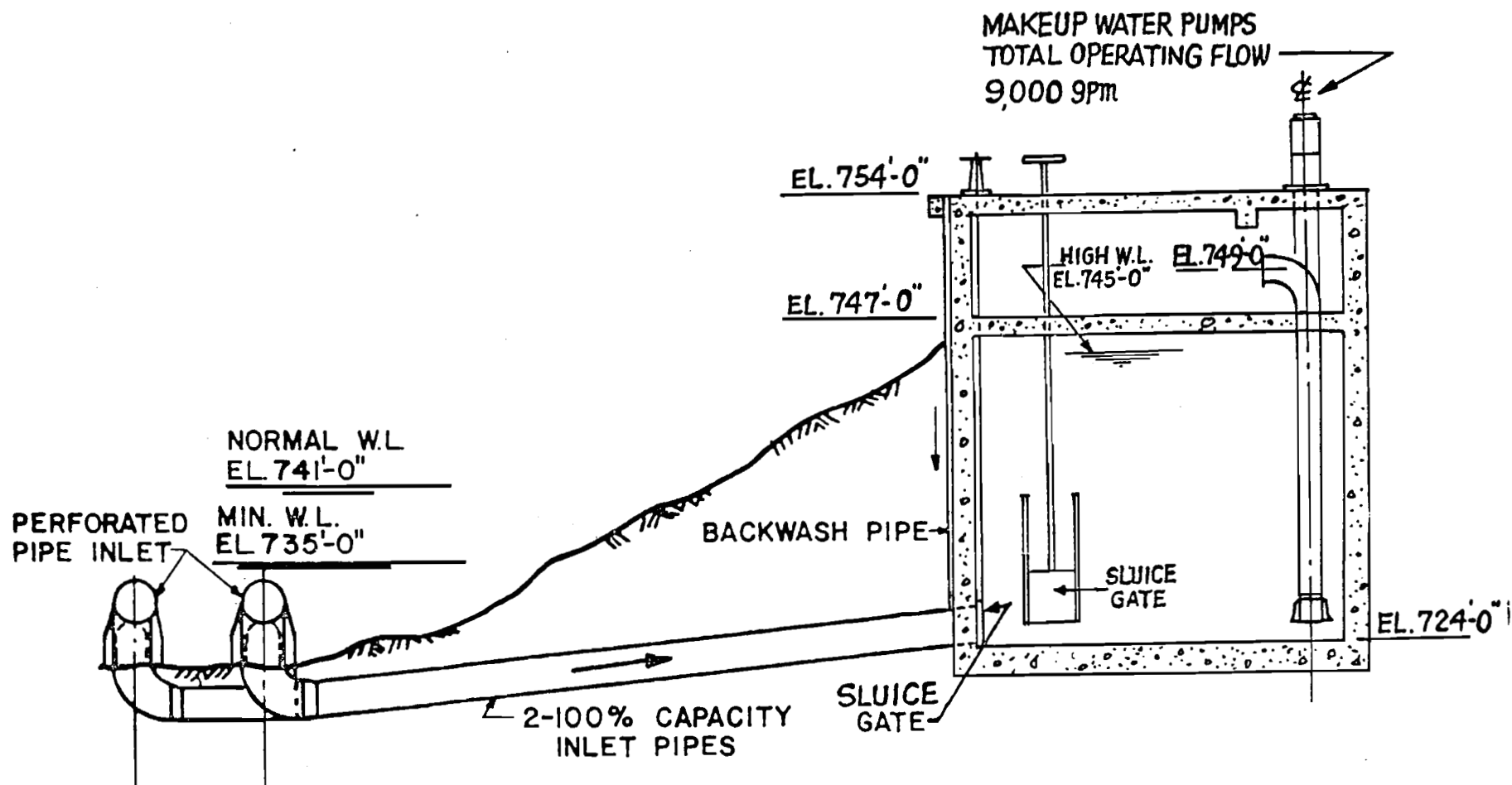


Figure A3.6 Perforated pipe intake system (replaces FES Fig. 3.8)

3.5.1 Liquid Waste (NPDES 010)*

3.5.1.1 Intermediate Activity System

The intermediate activity system (IAS) would process aqueous radioactive waste generated from the washing of contaminated plant components in the large component cleaning vessel (LCCV) and the small component cleaning autoclave (SCA), formerly the intermediate component cleaning cell (ICCC). Based on the applicants' projected component maintenance schedule, the cleaning process now is estimated to produce an average volume of 100,000 gal of aqueous waste per year, an estimate with which the staff concurs.

The input flow rate for the aqueous waste to be collected in the IAS collection tanks (which hold 20,000 gal each) is now estimated to be 340 gpd instead of the 400 gpd indicated in the FES (see Figure A3.7, which replaces FES Fig. 3.15 revised). The staff calculates the collection time to be 59 days. After collection, the waste would be processed, in batches, by filtration, evaporation (10 gpm), and demineralization before it is collected in one of the 20,000-gal monitoring tanks.

3.5.1.2 Low Activity System

The low activity system (LAS) would process the aqueous waste effluents from the floor drains, shower drains, and laboratory drains in the plant and in the reactor service building. After processing, this waste would be collected in one of the two 2400-gal collection tanks at an input rate of 850 gpd (see Figure A3.7). (In FES Fig. 3.15, collection tank capacity was given as 2500 gal.) The staff estimates the collection time will be 2.8 days, slightly more than estimated in the FES. After collection, the waste would be batch processed by filtration, evaporation (10 gpm), and demineralization and then collected in one of the 2400-gal monitoring tanks (also a change from the FES in which tank capacity was given as 2500 gal).

3.5.1.3 Balance of Plant Releases

Tritium buildup in the steam-water system would be controlled by approximately a 5-gpm bleed from the condensate and feedwater system discharged to the environment via the cooling tower blowdown. The applicants now estimate the tritium release to be approximately 2.3 Ci/yr, considerably less than the 330 Ci/yr estimate in the FES. This estimate appears reasonable and the staff agrees with it.

In FES Table 3.3, the values for H-3 and the total should be changed to 2.3 Ci/yr.

3.5.1.4 Liquid Waste Summary

Based on its evaluation of the radioactive liquid waste treatment systems, the staff calculated the release of radioactive materials in the liquid waste effluent to be approximately 0.016 Ci/yr, excluding tritium and dissolved gases. The applicants now estimate these releases to be 8.7×10^{-4} Ci/yr, excluding tritium

*The nonradioactive components of the liquid waste are regulated by EPA under Clean Water Act (see Appendix H).

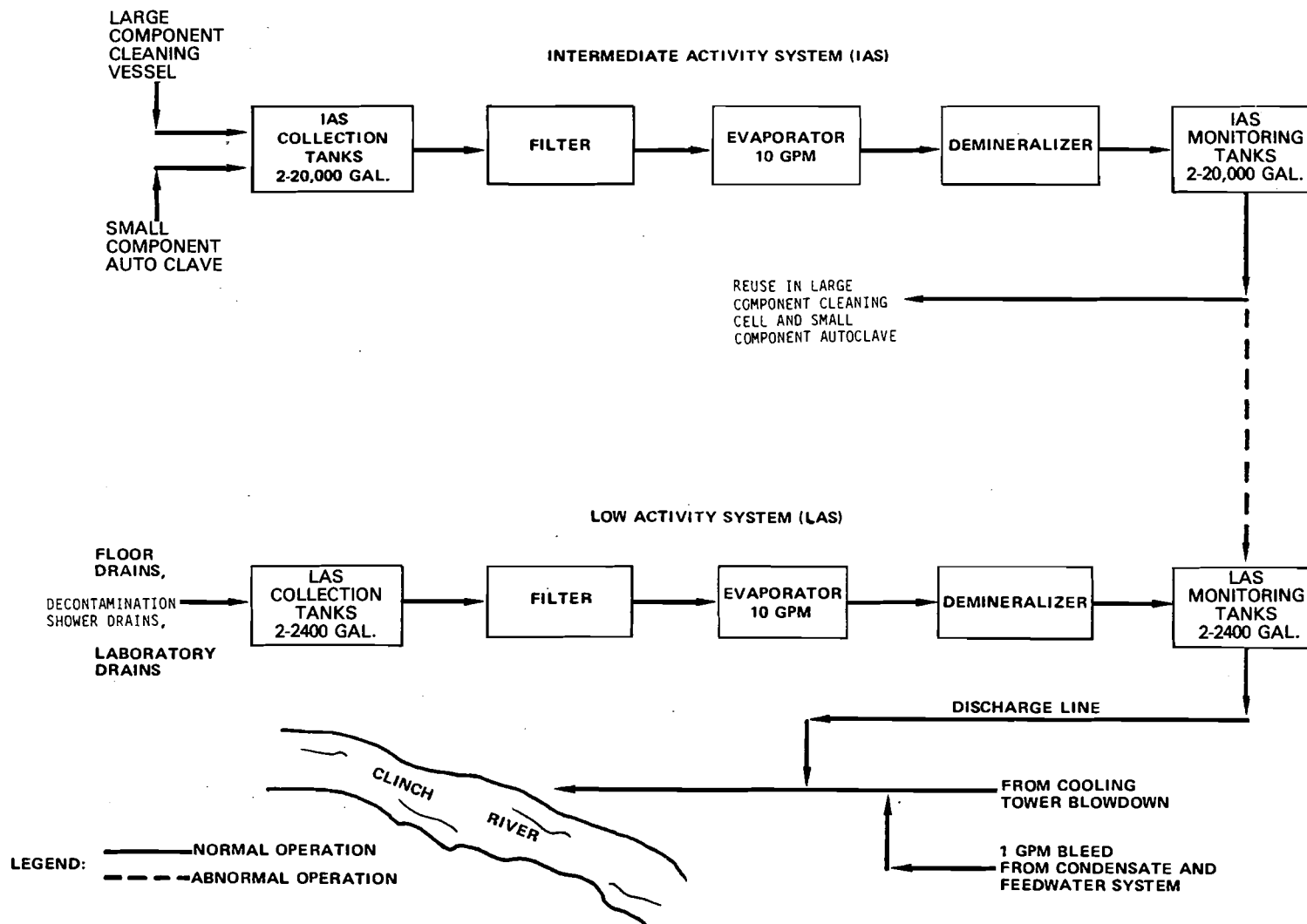


Figure A3.7 Liquid radioactive waste system
(replaces FES Fig. 3.15)

and dissolved gases, instead of 6.1×10^{-5} Ci/yr. The staff results differ from those of the applicants because of the staff's use of different values for assumed defective fuel, plant capacity factor, the volume of waste released from the IAS, the quantity of radioactive sodium waste input to the LAS, the decay time prior to collection in the LAS, and the evaporator decontamination factor for iodine.

3.5.2 Gaseous Waste

Changes in FES Figure 3.16 (herein Figure A3.8) are discussed below. In the first sentence of the text, "store" has been deleted.

3.5.2.1 Radioactive Argon Processing System

The radioactive argon processing system (RAPS) would continuously process and recycle the primary sodium system cover gas (argon) and provide a source of low radioactivity gas for use in reactor seals. In the process, as revised from that described in the FES, radioactive cover gases from the spaces in the reactor, reactor overflow vessel, and primary system pumps would be collected in the vacuum vessel and transferred by compressor to the surge vessel where they would be stored under pressure (Figure A3.8). The RAPS recycle system would consist of a vacuum vessel, two compressors, a surge vessel, a cryogenic still, a noble gas storage tank, and a recycle argon vessel.

The effluent gases from the surge vessel would enter a cryogenic still that has liquid argon in the still bottom. The still removes the krypton and xenon isotopes and collects them in the bottoms. By periodic draining and evaporating, the isotopes are transferred to the noble gas storage vessel. The purified argon would be directed to the vacuum vessel as recirculation throughput (4.85 scfm) and to the recycle argon vessel (5.15 scfm) for reuse in the primary system as cover gas. The applicants propose to process gases from the noble gas storage vessel through the cell atmosphere processing system. The staff model assumes that the contents of the storage vessel would eventually be released to the environment, through the cell atmosphere processing system (CAPS).

3.5.2.2 Cell Atmosphere Processing System

The CAPS would collect and process the gaseous radioactivity that may leak or diffuse into cells (containing nitrogen atmosphere) which house the reactor, primary heat transfer system (PHTS), PHTS pumps, and reactor overflow vessel. The major inputs to CAPS would also consist of gases from the noble gas storage vessel, the mass spectrometer, and gas services exhaust. The provision that CAPS also collect and process any leakage of gases in the nitrogen or air atmosphere cells housing the RAPS and CAPS components, as described in the FES, is no longer included. The CAPS will consist of a vacuum vessel, compressors, a surge vessel, an oxidizer, tritium water removal unit, and two cryogenic charcoal beds. Inputs to the CAPS would be collected in the vacuum vessel and transferred by compressor to the surge vessel, passed through the oxidizer and the tritium water removal unit, and finally treated in the charcoal beds. Because the flow input to the CAPS would be variable, the staff has assumed for its calculations that the rate through the charcoal beds would be 50 scfm.

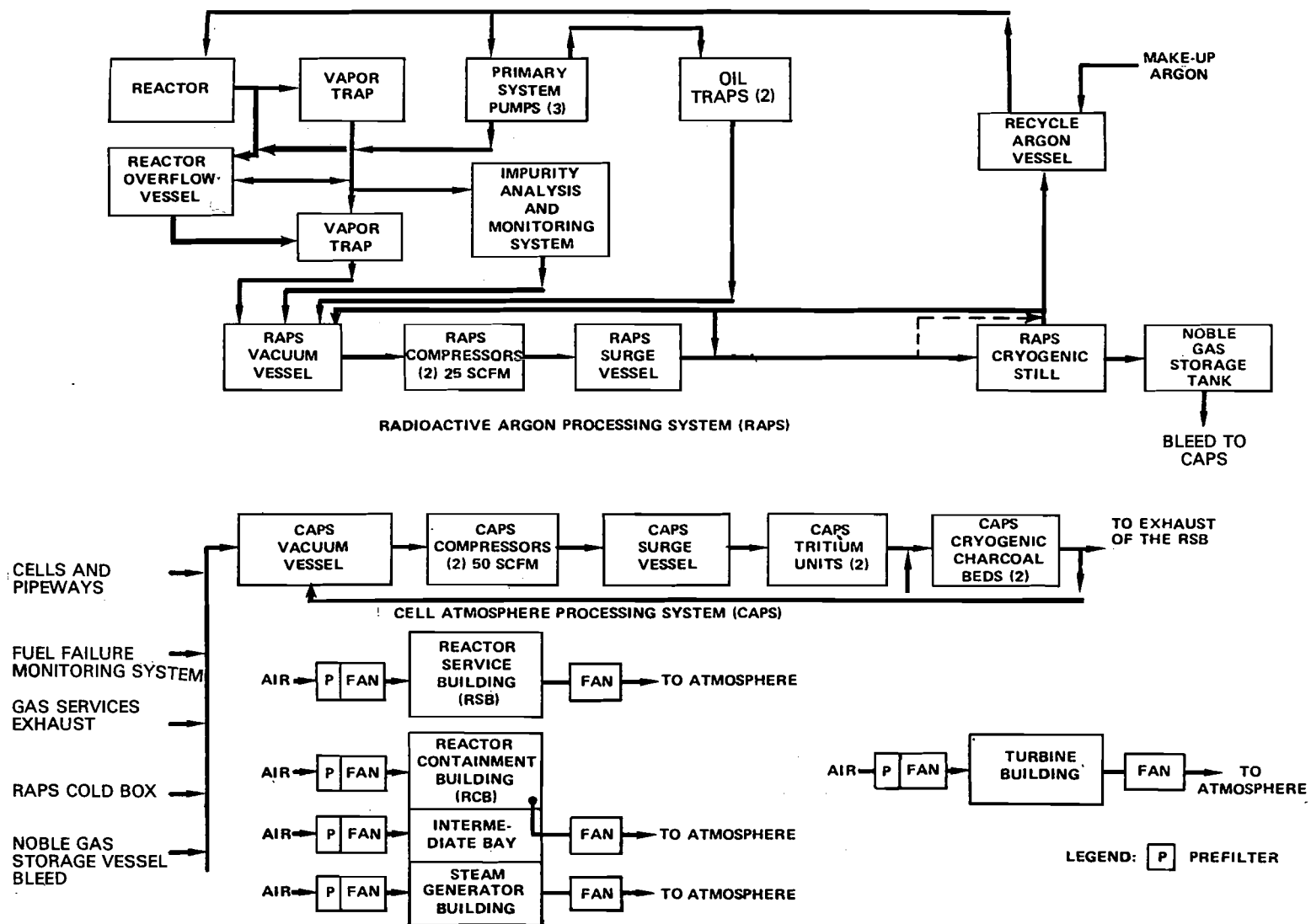


Figure A3.8 Gaseous radioactive waste systems and CRBRP ventilation (replaces FES Fig. 3.16)

3.5.2.3 Reactor Containment Building Ventilation System

The atmosphere in the head access area would be ventilated by an air stream exhausted to the environment through the independent reactor containment building (RCB) ventilation system without treatment. The estimated volume of this air stream has been increased to 14,000 cfm from the 12,000 cfm estimate in the FES.

3.5.2.4 Intermediate Bay Ventilation System

Tritium that diffuses from the PHTS into the intermediate heat transfer system (IHTS) also would diffuse at a small but finite rate through the IHTS piping and components into the intermediate bay (IB) cell atmospheres. The cell atmospheres would be vented to the environment through the IB ventilation system with a total flow rate of 64,000 cfm.

3.5.2.5 Turbine Building Ventilation System

A small quantity of tritiated water vapor would be removed from the steam water system by the mechanical vacuum pumps of the condenser offgas system along with noncondensable gases. According to the revised design of the turbine building ventilation system, the gases would be discharged through the turbine generator building lube oil areas exhaust duct with a flow rate of 8000 cfm.

3.5.2.6 Gaseous Waste Summary

The staff calculates that the release of radioactive materials in gaseous effluents would be about 389 Ci/yr (the same as in the FES) for noble gases and 1 (instead of 3.1) Ci/yr for tritium. In comparison, the applicants estimated a total release of 210 (instead of 6.4) Ci/yr for noble gases and 0.1 (instead of 3.1) Ci/yr for tritium. The staff used a different parameter for defective fuel and increased the tritium release by a factor of 10, for the reasons stated in FES Section 3.5.1.4.

In FES Table 3.4, the H-3 releases in Ci/yr should be shown as 0.1 from RCB, 0.6 from IB, 0.3 from TB, and 1.0 total.

3.5.3 Solid Waste

The applicants now estimate that approximately 1100 (instead of 1000) ft³ of solidified liquid radwaste containing 2800 (instead of 56) Ci of activity would be shipped off site annually. The staff agrees with this estimate.

The staff also agrees with the applicants' revised estimate that approximately 800 (instead of 1500) ft³ of noncompactible solid waste containing 300 (instead of 100) Ci of activity would be shipped annually.

Metallic sodium waste from fuel handling operations would be processed into a form suitable for shipment to a burial facility or for onsite storage. The staff agrees with the applicants' revised estimate that approximately 15 (instead of 42) ft³ of sodium waste containing 40 (instead of 10) Ci of activity be generated annually and approximately 750 (instead of 240) ft³ of sodium-bearing waste containing $1.6 \text{ (instead of } 1.9) \times 10^4 \text{ Ci}$ of activity would be generated annually.

Table A3.2 Preliminary estimates of effluent water concentrations¹

	Clinch River		CRBRP waste streams			Discharge to river			
	Background ²		Cooling tower blowdown ³		Neutralized plant wastes ⁴	Sanitary wastes	Annual quantity	Concentration	
	Avg conc. (mg/l)	Max conc. (mg/l)	Based on avg river conc. (mg/l)	Based on max river conc. (mg/l)	Based on avg disch--100 gpm (mg/l)	Based on design loading (mg/l)	(10 ³ lbs/yr)	Avg (mg/l)	Max (mg/l)
Total alkalinity (as CaCO ₃)	87.0	100.0	40.0	40.0	50.0	--	--	40.00	40.00
Ammonia nitrogen (as N)	0.04	0.23	0.10	0.58	--	<5.0	0.7	<0.1	<0.6
BOD	<1.0	1.3	<2.0	<3.0	--	<30.0	<14.5	<2.0	<3.0
Calcium	29.0	35.0	72.0	87.5	43.0	--	518.0	71.0	86.0
Chloride	3.0	40.0	7.50	100.0	43.0	--	71.0	9.0	97.0
Residual chlorine	⁵	⁵	<0.14	<0.14	--	1.0	1.0	<0.14	<0.14
COD	<4.0	12.0	<10.0	<30.0	--	NA	<69.0	9.6	28.7
Copper ⁶	0.036	0.170	<0.2	<0.5	<1.0	--	<1.7	<0.20	<0.5
Total dissolved solids (TDS)	125.0	150.0	266.0	320.0	1,350	--	2,436.0	310.0	362.0
Total iron ⁶	0.530	6.50	<1.3	<16	--	--	9.2	<1.27	<15.5
Lead	<0.011	0.035	<0.028	0.088	--	--	<0.2	<0.026	<0.084
Magnesium	7.7	9.4	19.25	23.5	12.0	--	138.0	19.0	23.0
Manganese	0.055	0.180	0.138	0.450	1.0	--	1.4	0.13	0.43
Nickel ⁶	<0.050	0.060	<0.13	0.150	<1	--	1.3	0.17	0.19
Nitrate (NO ₃)	0.45	1.4	1.13	3.5	3.2	--	9.2	1.2	3.5
pH	7.6	8.2	7.6	6.5-8.5	6.5-8.5	6-9	NA	6.5-8.5	6.5-8.5
Total phosphate	0.02	0.04	--	--	1.0	5.0	--	--	--
Potassium	1.26	1.7	3.2	4.2	2.0	--	23.0	3.1	4.1
Silica (SiO ₂)	4.3	6.0	10.8	15.0	6.5	--	78.0	10.6	14.6
Sodium	3.3	7.0	8.2	17.5	345.0	--	208.0	22.0	31.0
Sulfate (SO ₄)	16.0	27.0	210.0	269.0	780.0	--	1,798.0	233.0	290.0
Total suspended solids (TSS)	7.0	40.0	20.0	100.0	<30.0	30.0	152.0	20.0	100.00
Zinc ^{6,7}	0.025	0.120	0.064	0.310	--	--	0.4	0.061	0.30

¹Adapted from ER Amendment XVI.²Based on "Status of the Nonradiological Water Quality and Nonfisheries Biological Communities in the Clinch River Breeder Reactor Plant, 1975-78," TVA, Feb. 1979.³Includes several minor recycled waste streams (makeup water system equipment rinses, backwashes, and blowdown; nonradioactive floor drains). These do not measurably affect the cooling tower blowdown chemical concentrations.⁴Includes makeup water demineralizer and steam condensate polisher regeneration wastes, auxiliary boiler blowdown, and nonradioactive lab and sampling wastes.⁵Field measurements using the orthotolidine colorimetric method repeatedly showed the chlorine residual concentration to be below the limits of detection (<0.05 mg/l). As there are no nearby sources of chlorine additions to the river, it can be assumed that the ambient level is zero.⁶Includes contribution to effluent for condenser erosion/corrosion.⁷A single occurrence of zinc in the concentration of 570 µg/l was reported for April 14, 1976 at a 16-ft depth. The same station on the same date reported a concentration at 3 ft and duplicate field samples at a 10-ft depth were <10, <10, and 20 µg/l, respectively. The reason for the outlier value at the 16-ft depth is unknown, but sample contamination is suspected. The 570 µg/l value was not included in the table because of its questionable validity.

The applicants now estimate that approximately 210 (instead of 290) ft³ of compacted waste containing less than 1 Ci of activity would be shipped off site annually.

3.5.3.1 Solid Waste Summary

As stated in the FES, the staff concludes that the solid waste system is acceptable. The waste would be packaged and shipped to a licensed burial site in accordance with NRC and Department of Transportation regulations, or stored on site.

3.6 Chemical Effluents

The revised EPA draft NPDES Permit that would limit chemical discharges as necessary to protect other water users is included as Appendix H to this document. The notable changes in the FES discussion of chemical waste effluents are given below.

3.6.1 Circulating Water System Output (NPDES 001 and 011)

Consumptive use of water at the plant will be essentially the result of evaporation in the cooling towers. As shown in Figure A3.4, an average of 3729 gpm would be lost by evaporation and drift from the tower out of a makeup stream of 6145 gpm. Chemicals or chemical species expected to be in plant cooling water discharged to the river are shown in Table A3.2 of this assessment (ER Am VIII, Table 3.6-1, which replaces FES Table 3.5). The comparison of chemical concentrations in the station effluent shown in FES Table 3.6 have not been revised here because the NPDES Permit Rationale demonstrates how Federal effluent limitations and state water quality criteria are considered in developing permit limitations (see Appendix H).

3.6.2 Chemical Biocides (NPDES 011)

Hypochlorite would be injected periodically into the circulating water line upstream of the main condenser for biocide treatment of the condenser, the cooling towers, and plant auxiliary cooling equipment. Chlorination will be accomplished in compliance with Federal effluent limitations and state water quality criteria. The draft NPDES Permit limits the instantaneous maximum concentration of total residual chlorine to 0.14 (instead of 0.5) mg/l.

3.6.3 Water Treatment Wastes (NPDES 009)

Approximately 110,000 (instead of 96,000) gal of river water would be treated each day to meet the plant's process water needs. The raw river water would be treated by coagulation/sedimentation and filtration to remove particulate matter. Clarified water from the process water treatment systems would be treated further by ion exchange to produce demineralized water for the steam cycle and other plant uses. The ion exchanger demineralization process will use sulfuric acid and sodium hydroxide to regenerate the ion exchange beds (ER Sec 3.6.3). Fig. A3.9 (supersedes FES Fig. 3.17) shows the current plan for the waste water treatment system.

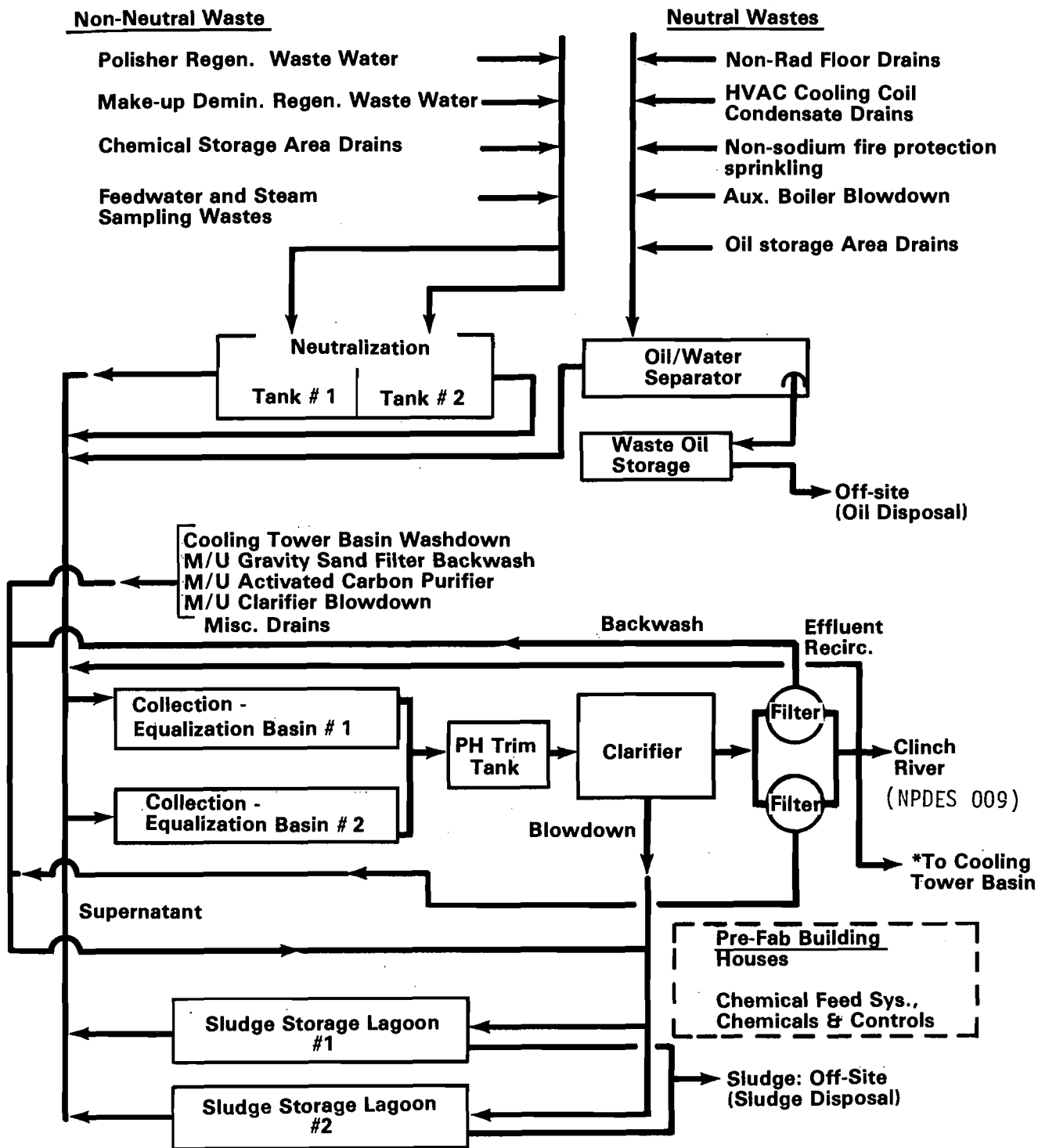


Figure A3.9 Chemical waste treatment system
(replaces FES Fig. 3.17)

3.6.4 Condensate Polishing System Waste Discharges (NPDES 009)

Regeneration cycle wastes and rinses from the condensate polishing system and the makeup water treatment system and other minor nonradiological process water waste streams are directed to the waste water treatment system. This system neutralizes pH and removes particulates before discharging the waste streams to the Clinch River. Effluent may be recycled as cooling tower makeup if chemical quality allows it.

3.6.5 Metal Cleaning Waste (NPDES 012)

The waste generated by metal cleaning procedures are proposed for disposal offsite in an environmentally acceptable manner. Details of such disposal are to be provided to EPA not later than 90 days before any cleaning operation. The draft NPDES Permit provides effluent limitations and monitoring requirements in the event that discharge at the plant site is ultimately utilized.

3.6.6 Oily Waste (NPDES 009)

The NPDES serial number has been added.

3.6.7 Polychlorinated Biphenyls (NPDES Part IIIB)

The draft NPDES Permit now prohibits discharges of polychlorinated biphenyls (PCBs) and requires that EPA be notified should major equipment containing PCBs be brought onto the site.

3.6.8 Chemical and Oil Storage

No changes are needed in this section of the FES.

3.6.9 Storm Drainage

The first sentence in this section of the FES has been reworded as follows: "Storm water would be collected from roof and yard drains and discharged to the Clinch River." Runoff treatment pond C will be retained after construction to collect runoff from the vehicle parking area.

3.6.10 Cooling Tower Drift

The anticipated rate of cooling tower drift now is estimated to be 106 gpm instead of 107 gpm.

3.6.11 Nonradioactive Chemical Coolants

No changes have been made to this section of the FES.

3.7 Sanitary and Other Waste

3.7.1 Sanitary Waste (NPDES 002)

The capacities of waste treatment facilities have been changed. Before the construction permit is issued, sanitary waste generated by personnel participating in site preparation under a limited work authorization would be treated by

a 13,000-gpd capacity extended aeration activated sludge sewage treatment. If the construction permit is issued, a larger extended aeration unit with a capacity of 52,000 gpd would be installed, giving a total capacity of 65,000 gpd. The larger unit would be abandoned or removed when construction is complete.

The 13,000-gpd unit would remain for treating the wastes generated during normal plant operation. The maximum number of personnel needed during annual shutdowns now is estimated to be 300. With an expected waste generation rate of 35 gpd per person, about 10,500 gpd of waste would be generated, which is within the capacity of the unit.

In the operation of the 13,000-gpd unit, chlorination would precede the discharge. The sand filters contemplated at the FES-CP review will not be included. The extended aeration unit alone is expected to remove 65 to 91% of the suspended solids and 75 to 95% of the biochemical oxygen demand. Table A3.3 shows the expected characteristics of the final effluent.

Table A3.3 Plant sanitary waste system estimated effluent characteristics

	Sanitary waste effluent (mg/l)	Draft NPDES Permit limit daily avg (mg/l)
Total suspended solids	5	30
BOD	12	30
COD	25	--
Total phosphate(PO_4)	5	--
Nitrate nitrogen(N)	15	--
Residual chlorine	1	N/A
Ammonia nitrogen(N)	0.5	--
pH	6.0-9.0	6.0-9.0
Fecal coliform (organisms/100 ml)	--	200*
Settleable solids (ml/l)		1.0

Source: ER Table 3.7-1 and NPDES Permit and 401 certification.

*From 401 certification. The permit and certification also contain maximum values and other detail. Both documents are included in Appendix H.

3.7.2 Other Waste

The first paragraph of this section has been revised to read:

The only nonradioactive gaseous effluents discharged into the atmosphere would be those in the exhaust from emergency operation or periodic testing of the three diesel generators, which serve the plant in case of power failure, and the diesel-driven fire pumps. The maximum rate of emission of pollutants from the largest of these standby units would be as follows: particulates, 1 lb/hr; sulfur dioxide, 72 lb/hr; nitrogen oxide, 402 lb/hr; organic compounds, 7 lb/hr; and carbon monoxide, 14 lb/hr. Testing frequency would be once per month for 2 hours or until normalization of operating conditions, whichever is sooner.

3.8 Power Transmission System

In FES Figure 3.19, the 161-kV transmission line passing through the CRBRP site should be labelled "DOE-Owned Ft. Loudon - K31 161 kV."

On page 3-26 of the FES first paragraph, fourth line, the following sentence should be inserted after "corridor":

Coordination with the State Historic Preservation Office was completed on May 1982 for the offsite portions of the expanded transmission line right-of-way. No field survey was required because records and past experience for the area and for the terrain show no significant potential for sites in the zone to be affected (see State Historic Preservation Office letter dated September 8, 1982, in Appendix C).

The next sentence (on page 3-26 of the FES, first paragraph, fourth line) should read:

Should any significant site be revealed in or in the close vicinity of the corridor, relocation of the corridor, relocation of specific towers, or possible excavation will be considered and done in consultation with the State Historic Preservation Office and the NRC (ER Sec 3.9.6).

On page 3-36 of the FES, the second sentence of the third paragraph should read: "The right-of-way is 37% hardwood, 43% pine, 10% mixed, and 8% un-forested (ER Table 3.9-1, Am IX)."

3.9 Conclusion Regarding Changes in Facility Description

The changes in the facility described above are not substantial and they do not result in significant changes or additions to the staff's assessment of the impacts from constructing and operating the CRBRP.

4 ENVIRONMENTAL IMPACTS DUE TO CONSTRUCTION

4.1 Construction Schedule and Manpower

Site preparation began in September 1982, and completion of this phase of the work is expected within 14 months. The applicants requested a Limited Work Authorization (LWA) under 10 CFR 50.10(e)(2) to perform certain safety-related construction activities before the anticipated issuance of the construction permit (CP) in June 1984.

The facilities to be constructed during site preparation are essentially as described in the FES. The 32-acre borrow pit shown in FES Figure 4.1 has been eliminated and the 25-acre quarry would now occupy 45 to 60 acres (Figure A4.1).

Although the construction phase is expected to last 7 years, most of the construction would be completed within 6 years. The fifth paragraph of this section in the FES should be deleted because the Centar enrichment plant and the Exxon reprocessing plant are no longer in current plans for the Oak Ridge area, and further construction of the Phipps Bend Nuclear Plant has been cancelled. Tennessee Synfuels Associates (TSA) plans to construct a coal-gasification plant about 2.5 miles northwest of the CRBR site, but the financing and timing of that project are uncertain.

Table A4.1 provides data on the labor required to construct and operate the CRBR. Updated information on the labor force and its probable impact on the community is presented in Section 4.5.

4.2 Impacts on Land Use

4.2.1 On Site and Immediate Vicinity

The total area now planned to be cleared and graded at the proposed CRBRP site is approximately 292 acres of mostly forested land, which is approximately 20% of the 1364 acres of the site (see Table A4.2). About 113.5 acres of the total area to be cleared would be permanently disturbed, including 34 acres for access roads and railroads, 10 acres for the meteorological tower area, 4 acres for barge unloading area, 2 acres for parking area, and 37 acres for all land within the security barrier. These increases of approximately 50% in land use are not significant because they will not affect any prime or unique land uses or special resources on the site and because the resources affected are of comparable quality to those in the vicinity.

Specific forest types that would be disturbed by construction activities are given in Table 4.1-2 of the applicants' ER (Am III).

As stated in the FES, timber of commercial value on the construction areas would be harvested and removed from the site in accordance with the DOE Forest Management Program. The remaining plants and brush would now be burned in accordance with state and Federal air pollution regulations (ER Sec 4.1.1); this would

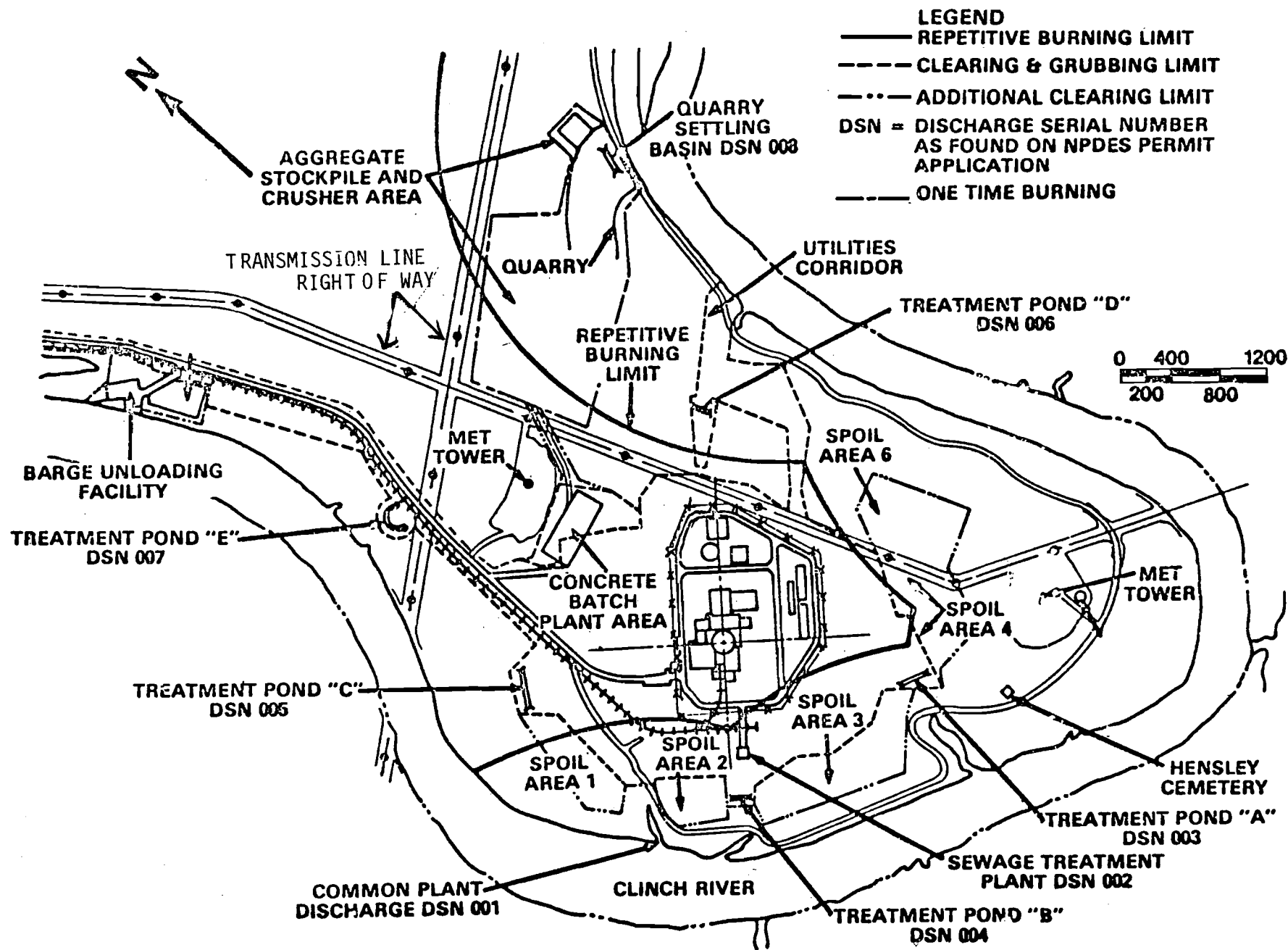


Figure A4.1 Proposed site construction layout

Table A4.1 Schedule of direct and induced employment for the CRBRP by type of employee¹

Type of employee	Construction phase (year after LWA)							Operation phase (year after startup)						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Direct manual	86	693	2551	3835	2924	883	55	0	0	0	0	0	0	0
Nonmanual	211	388	546	685	655	398	81	0	0	0	0	0	0	0
Subcontractor	304	210	190	163	244	178	23	0	0	0	0	0	0	0
CRBRP project office	267 ²	274	256	240	240	223	201	141	109	81	54	44	25	0
Contractor support	189	190	188	181	172	169	148	87	0	0	0	0	0	0
Operations ³	0	6	13	71	140	222	282	255	247	246	246	246	246	246
All types of direct employees	971	1761	3744	5175	4375	2073	790	483	356	327	300	290	271	246
Induced ⁴	17	27	24	31	48	69	75	77	75	75	75	75	75	75
Total direct and induced employees	988	1788	3788	5206	4423	2142	865	560	431	402	375	365	346	321

¹Reported numbers are yearly averages.

²237 project office staff and 142 contractor support personnel were already living in the project area as of February 1971.

³Includes security personnel during operation.

⁴The number of induced workers hired during the construction phase is based on the number of relocated direct relatively permanent workers hired by Contractor Support, Operations, and Project Office Staffs. The staff assumed a 50-percent in-mover rate for employees over and above the number of employees living in the project area for the employment groups listed above as of February 1981. The staff assumed a 1.6 multiplier for calculating induced employment by year with 75 percent of induced workers hired within the current year and 25 percent the following year.

Table A4.2 Land areas that would be affected by proposed site preparation activities*

Category	Acres disturbed	
	Temporary facilities	Permanent facilities
Access roads and railroads (onsite)	30	30
Access railroad (offsite)	4	4
Parking area	19	2
Barge unloading area	4	4
Impounding ponds	7	7
Quarry including stock pile area and crusher facility	60*	-
Concrete batch plant	5	-
River water intake, pumphouse, and discharge line and sanitary landfill areas	6	0.5
Spoil areas	43*	-
Storage and other work areas	67	-
Permanent plant building and all land within security barrier	37	37
Meteorological tower areas	10	10
Additional security areas required for 150-ft line of sight beyond security barrier--to be grassed and mowed	-	19
TOTAL	292	113.5

Source: ER Table 4.1-1 Am XIII, April 1982.

*Maximum

have a slightly adverse effect on air quality in the immediate vicinity. Conventional garbage would be disposed of offsite. The applicants have deleted the use of a borrow pit from their plans.

The barge-unloading facility (Figure A4.1) has been redesigned in a manner which minimizes dredging. The concrete-slab-on-piling type of barge-unloading

facility would now occupy a 125-by-185-ft area recessed into the river bank. On one side and one end of the area, sheet piling would be driven to form two boundaries of the area to be excavated. The bottom of the dredged area would be covered with about 700 yds³ of sand to cushion grounded barges during unloading.

Topsoil on the areas to be excavated would be removed and stockpiled for use in later landscaping. Beneath the topsoil, about half of the excavated materials would satisfy requirements for structural fill. The excess would be stockpiled for backfill. Additional backfill would now be obtained from the 45-acre quarry and stockpile areas (Figure A4.1). Building material (sand, stone, slate, limestone) would now be quarried on site. Surface soils of the quarry area would be stockpiled for revegetation of the quarry area at the end of construction.

The Indian Mound has been excavated and no longer exists.

The above changes do not significantly affect the staff's impact assessments in Section 4.4.

4.2.2 Transmission Lines

About 61 acres, rather than 54 acres, would be used for transmission lines. This is not a significant increase in environmental impacts.

4.3 Impacts on Water Use

The maximum water requirement during construction would be 210,000 gpd, up from the figure of 190,000 gpd given in the FES, about 0.007% of the river's annual average flow. Water for other than quarry use could be as much as 150,000 gpd and would be piped along existing roadways from the nearby Bear Creek Water Filtration Plant. This small increase in water use is not environmentally significant.

4.4 Ecological Impacts

4.4.1 Terrestrial

Construction would result in the harvesting of timber and the destruction of some other plant and animal life on 292 acres concerned with the plant (Table A4.2) and 58 acres in connection with the transmission lines, both on and off site. This increase of approximately 50% percent over the 195 acres (stated in the FES) to be cleared for construction of the plant proportionately increases the amount of biota affected. However, the biota affected would still be less than 1% of such resources on the Oak Ridge Reservation. The staff therefore concludes that their increased impact is not environmentally significant.

Two plant species, Cimicifuga rubifolia and Saxifraga careyana, under status review by the Fish and Wildlife Service (FWS), have been identified on the proposed site (see Section 2.7.1.1). Based on field studies and procedures adopted by the applicants, safeguards have been developed to ensure protection of these critical elements (Section 4.6.1.1(16)).

Under the applicants' restoration plans, the 45 acres for the quarry would probably start supporting wildlife about 10 years after restoration and provide habitat equivalent to the present habitat in another 10 years.

4.4.2 Aquatic

The second sentence of the second paragraph of the FES has been revised to read:

The staff recommends that the cofferdam be installed and removed when sauger are not spawning and striped bass are not utilizing the Clinch River as a thermal refuge unless it can be substantiated that there will be no adverse effects.

The river and shoreline area to be excavated or dredged during installation of the pumphouse and intake pipes is now described as having an area of 9400 ft² (the FES states that 3440 m³ of river bottom would be excavated); this is not a significant change.

The discharge pipe would be installed with some excavation and dredging taking place. Approximately 2600 ft² (the FES states that 190 m³ of river bottom would be excavated) of river bottom and shoreline would be disturbed; this is not a significant change.

About 11,000 yds³ (instead of 14,500 m³ (19,000 yds³)) of material would be dredged to accommodate the barge-unloading facility; this is a slight reduction in terms of impact. Approximately 700 yds³ of sand fill (rather than 4940 m³ (6500 yds³) of granular fill) would be used to line the bottom of the facility. About 600 linear feet of shoreline and about 1700 ft² of river bottom below the 741-ft elevation would be disturbed during construction. The sequence of construction for the facility is: drive piling, construct concrete slab, excavate bottom, and place sand as required. Aquatic life would be destroyed in the area of the barge-unloading facility. However, based on the amount of area impacted, the temporary nature of the activities, and the fact that a large portion of this area is dry during part of the year, no significant long-term impact is expected.

Limited dredging and placement of granular fill and riprap would be associated with improvement of the access road and construction of the railroad spur. These activities would impact approximately 34,000 ft² of existing river bottom below the normal pool elevation of Watts Bar Lake. Deposition of the fill material would initially destroy the underlying benthic community; however, this impact would be temporary, and benthic organisms would rapidly colonize the new rock substrate. The staff recommends that fill material not be placed in the river during the period in late summer when striped bass are utilizing the Clinch River as a thermal refuge or in late spring when sauger are spawning.

Clearing rights-of-way for the transmission corridors and moving construction equipment along the corridors would result in some soil erosion and stream siltation. Such effects, although significant for the streams affected, would be temporary and even areas severely affected would be recolonized. FES Section 3.8 describes construction practices designed to minimize these effects.

An Erosion and Sediment Control Plan for the planned construction activities at the site has been approved by EPA and the State of Tennessee. The objective of the plan is to control the erosion and sedimentation resulting from construction activities by minimizing soil exposure, collecting and controlling rainfall runoff in the construction area, and by shielding and/or binding soil on cut slopes where stabilization is required. Sedimentation to the Clinch River would be controlled by placing runoff treatment ponds and filters so they collect and treat rainfall runoff.

The plan incorporates the EPA and State of Tennessee standards of performance for new sources, best professional judgment, and other applicable guidance documents to control the potential pollution resulting from the construction activity. The extent and comprehensiveness of the plan eliminates the need for an aquatic biological monitoring program. The plan requires that specific methods be used to minimize erosion from water, wind, and gravity as described in the above paragraph.

The NPDES Permit, Page I-3, sets forth effluent limitations and monitoring requirements for point source runoff from areas of construction. As noted in the NPDES Permit Rationale, these requirements are based on 40 CFR 423.45 and best professional judgments. Use of runoff collection ponds with filtration is considered by EPA to be a best management practice for control of site runoff.

In summary, the aquatic ecosystem, including the Federally protected species, Lampsilis Orbiculata Orbiculata, is expected to sustain no significant impact from construction of the plant and transmission lines provided that: (1) activities are timed to minimize effects during critical periods of biological activity in the Clinch River, (2) construction practices to minimize impact as recommended by the staff are followed, and (3) requirements in the Erosion and Sediment Control Plan and the NPDES Permit are met.

The above changes and additional information do not constitute a significant change in the FES assessment of ecological impacts.

4.5 Impacts on the Community

This section now includes relevant material in FES Section 4.1. To a large extent, the severity of socioeconomic effects is dependent on time. In the case of Clinch River, the staff felt that enough time had passed since the earlier analysis was completed to warrant a reanalysis of socioeconomic effects. Moreover, certain background factors (competing construction projects) had changed as did the assumptions originally used by the staff analysts. The resulting analysis differs considerably from that which was developed for the staff's FES and is presented below.

4.5.1 The Inmover Construction Labor Force

Existing residents of the four-county impact area would supply most of the demand for labor through the release of construction laborers and craftsmen from other construction projects, through the movement of laborers as they are bid away from other industries, and through a decline in unemployment. The applicants' analysis (ER App C) discusses a range of 26 to 40% inmovement of

construction labor, which is based on TVA experience in constructing nuclear power stations. The lower value reflects TVA construction experience and ordinary competition for regional labor. The upper value reflects the possibility that other large, heavy construction projects--notably the TSA (Koppers) coal gasification plant--could bid for skilled workers from the same labor shed supplying the proposed CRBRP during the same time frame.

Additional employment could be induced by the presence of a large labor force on the CRBRP project. The effect would be felt in the entire region, but nowhere so concentrated as in the immediate project area. Induced employment would arise because the purchasing power of the CRBRP labor force would create an increased demand for goods and services. The applicants reference an Appalachian Regional Commission study (ER Sec 8.2.2.2) showing, for Anderson County, that every economic base job generates an additional 0.75 job in local service and production activities. The applicants adopted a multiplier of 1.6 that more closely reflects the temporary nature of impacts associated with construction projects than does the multiplier calculated by the Appalachian Regional Commission (ER Table 8.2-3). The applicants further assumed that because workers would not migrate to fill indirect employment opportunities created by the proposed CRBRP, levels of immigration would not be affected by the number of indirect jobs created (ER App C, Sec 1.0). The staff agrees with these assumptions and finds them reasonable in light of the temporary nature of construction employment.

At an inmovement level of 26% many as 1300 direct employees might move into four-county impact area during the peak year of construction (ER Sec 8.3.2.1). The corresponding figure at the 40% level would be 2000. Previous TVA studies indicate that 70% of the employees moving into an area are accompanied by their families, which contain 3.2 persons on the average (TVA, 1981, 1979, 1980, 1980a, 1978, and 1980b). Applying these factors to the number of inmoving workers under both migrant conditions yields the total number of people who would move into the four-county area during the peak year of construction. At the lower level of migration the number of people would be 3200, whereas 5040 people would move into the impact area under the higher alternative assumption (ER App C, Sec 1.0).

4.5.2 Distribution of Inmover Construction Labor Force

The ability to absorb a temporary population influx in existing communities will depend to a large degree on the distribution of the new population among those communities. The average construction worker is willing to commute long distances (approximately 50 miles), if necessary, to take a temporary job. However, as the commuting distance increases beyond 50 miles, construction workers increasingly prefer to relocate in either transient housing (rental units, hotels, motels, rooming houses) or mobile homes.

Once the decision to relocate is made, construction workers typically consider the following factors at a minimum in deciding upon the specific communities in which to locate:

- (1) distance to the site
- (2) size of the community
- (3) housing vacancy rate
- (4) prevalence of mobile homes

In general, construction workers will move to areas that are close to construction sites to minimize the time and cost of travel and to communities which are either large or close to large communities whose facilities and services are attractive. A relatively high vacancy rate suggests the availability of housing, while the importance of mobile homes reflects the temporary nature of construction industry employment (NUREG/CR-2002).

More specifically, the applicants based their assignment of inmoving workers to individual jurisdiction on TVA experience at six nuclear plant construction sites (TVA, 1981, 1979, 1980, 1980a, 1978, and 1980b). Differences between these six cases and the four-county area in terms of municipal population size, distances to the sites, housing additions by type, and the location and capacity of highways were used to adjust the level of inmovements to specific jurisdictions. Planners from local planning agencies were also consulted prior to developing the final distribution of workers (applicants' response to Question 19 in Amendment X).

FES Figure 4.2 shows the road mileage distances between the site and nearby population centers; FES Figure 4.3 shows existing and potential mobile home sites.

In the opinion of the staff, the highest concentration of inmover construction workers would be in the Rockwood-West Knox County strip because this zone combines the factors of accessibility to the site and suitability of temporary housing. The lack of mobile homes and high housing costs would probably make the City of Oak Ridge a less attractive place to locate than might be inferred from its proximity to the site and its urban attractions.

The area along Highway 61 between Clinton and Oliver Springs in Anderson County is considered to be a zone of potential mobile home sites that is within acceptable commuting distance to the site and easy access to shopping centers in Oak Ridge. However, the property tax rate of Anderson County is one of the highest in the state and an inmover would have to balance the possible advantages against higher living costs. Lenoir City in Loudon County is only about 20 miles from the site and would be considered an acceptable commuting distance for inmoving temporary construction workers.

Those inmovers desiring a more urban life might choose to settle in the vicinity of Knoxville despite the 37-mile commute (each way). The staff's judgment is that only a small fraction of construction inmovers would choose to do so because of opportunities closer to the proposed CRBRP site. However, even if many did, Knoxville, with a 1980 population of 183,139, could absorb an influx better than a smaller municipality because the percentage of change would be much smaller. Table A4.3 indicates the applicants' estimated allocation of inmoving workers and their families to communities within the four-county impact area.

4.5.3 Social Effects

Except for possible traffic problems, construction workers who do not relocate in order to become employed on the project would not cause any social change. They would use the same public and private sector services that they always used. However, inmoving construction workers and their families could cause

Table A4.3 Estimated number and location of relocated CRBRP project employees, spouses, and children at peak of construction activity

County	% of movers	26% inmovement		40% inmovement	
		Population		Population	
		Total	School age	Total	School age
Anderson					
Oak Ridge	15	480	100	756	147
Clinton Area	5	160	30	252	49
Knox					
Knoxville	5	160	30	252	49
West Knox County	40	1290	240	2016	392
Loudon					
Lenoir City Area	10	320	60	504	98
Roane					
Kingston Area	15	480	100	756	147
Rockwood Area	5	160	30	252	49
Harriman Area	5	160	30	252	49
Total	100	3210	620	5040	980

Source: ER, Table 8.3-3

social changes as a result of making added demands on housing, schools, and other publicly and privately delivered services. The following sections address the problems generated by new, temporary population additions to the four-county area of Anderson, Roane, Loudon, and Knox. Although some inmoving construction workers might choose to live in the more distance counties such as Morgan, Cumberland, Scott, Campbell, Blount, Monroe, McMinn, Meigs, and Rhea, the numbers of such workers to be considered are so few as to constitute a negligible impact.

Housing

Tables A4.4 and A4.5 summarize the housing requirements for relocating direct project employees at the peak of employment. The numbers reflect in part the estimated availability of specific housing types in different places (ER Sec 8.3.2.1.1). Knox County would experience the greatest demand for housing, and the majority of the demand for mobile home sites would be in Roane County. A large part of the demand for mobile homes sites would be in nonincorporated areas near towns and cities (ER App, Sec 2.1).

Under both inmovement scenarios no community other than Kingston, Lenoir City, or Oak Ridge would experience housing pressures during the peak construction period because of the availability of housing units; that is, the number of units annually added to the housing stock would be sufficient to accommodate increased demand (ER Sec 8.1.3.1, Tables 2.11 through 2.18.) If housing

Table A4.4 Estimate of housing units required at peak employment for inmoving construction workers under alternative scenarios

Place	Inmovement level	
	26%	40%
Anderson County	65	99
City of Oak Ridge	190	299
Knox County	571	896
Loudon County	125	199
Roane County	320	479
Total*	1270	1990

Source: ER Table 8.3-4 and Appendix Table 2.1-8.

*Sum of numbers may not equal totals because of rounding.

Table A4.5 Estimate of housing types required at peak employment under alternative scenarios

Housing type	Inmovement level	
	26%	40%
Single family	613	959
Multi-family	295	464
Mobile home	361	567
Total*	1270	1990

Source: ER Appendix Tables 2.1-4 and 2.1-8.

*Sum of numbers may not equal totals because of rounding.

construction activity between 1980 and the mid-1980s does not exceed levels prevailing during the 1970s, Oak Ridge, Lenoir City, and Kingston could be faced with tight housing markets during the peak construction period. Additional data are in Section 8.1.3.1 and ER Appendix Tables 2.1-1 through 2.1-8.

The staff supports the applicants' assessment and finds that it is conservative because the analysis does not consider (1) doubling up of inmoving workers who are unaccompanied by families and single workers (30% percent of total), and

(2) the use of motels and hotels as transient housing. Both considerations would reduce projected needs in the housing markets considered by the applicants.

School Systems

Enrollment statistics for county and city school systems are provided in Tables A4.6 and A4.7. These data include enrollments for the 1980-81 school year and for the peak construction year, assumed to be 1987. As indicated in Table A4.6, the school systems in Anderson County, Clinton City, Oak Ridge, and Harriman have moderately high levels of excess capacity while the remaining systems are either close to or exceed full utilization.

During the peak year of construction three of the eight school systems for which data are available could experience enrollment levels exceeding system-wide capacity. For the Knox County school system, the overutilization could reach 6%. Harriman and Loudon schools would have lower levels of utilization for the year coinciding with peak onsite employment (ER App Sec 2.2).

The applicants estimated the need for additional teachers and classrooms under both inmovement scenarios (ER App Sec 2.2). These data are summarized in Table A4.8. It should be noted that the applicants' analysis assumes that the student enrollment and the number of classrooms and teachers are in balance before any the impact of CRBRP project-related students would occur. Therefore, the data in Table A4.8 should be viewed as the additions required to meet increased demands at the peak of construction, assuming no underutilization.

In general, the staff agrees with the applicants' determinations of the impact on local educational systems. Nonetheless, several points should be borne in mind. First, as indicated, CRBRP could impact an already overutilized system in West Knox County. Of the 900 students above capacity in 1985 (under the 40% inmovement scenario), 400 would be project related. However, the peak of CRBRP project-related students would be present for less than 2 years when their numbers would decline (ER App Table 2.22). Second, the growth in the number of CRBRP project-related students in all systems would occur over a period of time, thereby permitting facility and personnel adjustments. Third, the applicants did not consider private schools as a potential resource which could be acceptable to some percentage of inmoving construction worker households. Finally, the State of Tennessee Department of Public Health has issued age-specific projections of population which indicate an overall 6% decline in school age children in the four-county area between 1980 and 1985. These figures are in marked contrast to estimates made by school authorities in the four-county impact area, which indicate increasing enrollment.

Transportation

The applicants' analysis of transportation impacts utilized the following assumptions:

- (1) no sponsored van or bus program
- (2) two persons per commuting vehicle

Table A4.6 Capacity and enrollment of area schools by system and grade:
1980-1981 school year

System	K	1	2	3	4	5	6	7	8	9	10	11	12	Total	Excess Capacity
Anderson															
Capacity	442	530	539	530	548	1501	1501	653	653	618	645	618	500	9,278	13.4%
Enrollment	429	514	523	514	532	1029	1029	626	626	592	626	592	400	8,032	
Clinton															
Capacity	138	160	117	149	160	160	181							1,065	15.0%
Enrollment	116	134	99	124	140	135	157							905	
Oak Ridge															
Capacity	360	372	391	409	477	501	496	496	490	515	508	583	602	6,200	18.7%
Enrollment	291	302	316	342	386	406	401	405	396	417	415	475	490	5,042	
Roane															
Capacity	428	564	578	593	592	564	571	565	578	571	528	535	471	7,139	6.8%
Enrollment	404	530	541	555	552	528	535	511	538	530	495	496	437	6,652	
Harriman															
Capacity	127	218	217	214	190	182	166	204	201	270	251	217	204	2,665	17.3%
Enrollment	125	182	178	168	156	149	135	168	164	226	207	178	168	2,204	
Knox**															
Capacity	1148	1042	1043	1043	1158	1148	1399	1375	1345	1271	1254	1118	969	15,113	-0.6%
Enrollment	1160	1053	1054	1054	1069	1160	1312	1388	1358	1251	1266	1129	949	15,203	
Loudon															
Capacity	300	122	409	383	335	370	364	376	346	225	225	190	161	3,806	1.3%
Enrollment	299	122	389	373	325	350	367	384	346	225	225	190	161	3,756	
Lenoir City															
Capacity	106	118	133	139	135	136	106	100	96	297	237	241	213	2,057	3.5%
Enrollment	106	118	110	114	110	136	106	100	96	297	237	141	213	1,984	

Source: ER Table 8.1-15.

*First 5 months of school year.

**Only the north, northwest, and southwest sectors of the Knox School System.

NOTE: The K-12 enrollment and capacity figures for the Knoxville City System are not included in this table because they do not maintain capacity numbers on a grade-by-grade basis. The June 1980 total system enrollment was 25,931 students with a system capacity of about 37,800 students.

Table A4.7 Projected school system capacities, enrollment, and excess capacities at peak of construction

System	Resident Capacity ¹	Enrollment ¹	26% inmovement	Enrollment increment at 40% inmovement	26% inmovement	Excess capacity at 40% inmovement
Anderson	9,278	8,558	15	25	705	695
Clinton	1,065	877	15	25	173	163
Oak Ridge	6,200	6,000	100	150	100	50
Roane	7,230	6,066	130	200	1040	970
Harriman	2,265	2,327	30	50	-92	-112
Knox ²	15,300	15,850	240	390	-790	-930
Knoxville ³	N/A	N/A	30	50	N/A	N/A
Loudon	3,806	3,842	40	65	-76	-101
Lenoir City	2,057	2,000	20	35	37	22

Source: ER Table 8.3-5 and Appendix Table 2.2-8.

¹Capacity and enrollment projected to 1987.

²Only the north, northwest and southwest sectors of the Knox School System

³The Knoxville City System was unable to provide projections for 1985 because of uncertainty of Knoxville's annexation proposals.

Source: ER Table 8.3-5 and Appendix Table 2.2-8.

Table A4.8 CRBRP project-related requirements
for teachers and classrooms for
alternative inmovement scenarios*

System	26% inmovement Teachers/Classrooms	40% inmovement Teachers/Classrooms
Anderson	**	**
Clinton	**	1
Oak Ridge	2	4
Roane	4	5
Harriman	**	2
Knox	8	12
Knoxville	**	2
Loudon	1	2
Lenior City	**	1
Total	15	29

Source: ER Appendix Tables 2.2-3 to 2.2-6

*Data are for peak year of construction, assuming
one new teacher is needed for each new classroom.

**Less than one-half

- (3) no truck deliveries to the construction site during the day shift commuting hours
- (4) CRBRP traffic would be staggered to avoid coinciding with existing rush hour traffic
- (5) three intersections (SR 95 and SR 58, SR 58 and Bear Creek Road, SR 95 and Bear Creek Road) would be upgraded
- (6) annual increase in non-CRBRP traffic equal to 2%.

The applicants estimate that 80% of the construction work force would work the day shift and would contribute the major CRBRP project-related traffic loads, estimated to be 2000 vehicles to the highway net (ER Table 8.3-6). Table A4.9 summarizes the effect of adding CRBRP project-related traffic to regional access roads in terms of "levels of service." Levels of service are gradations of traffic conditions ranging from free flow of low volume traffic at high speed (level of service A) to forced flow operation at low speed and vehicle volumes exceeding road capacity (level of service F) (Nat'l Acad Sci, 1965). The applicants' analysis indicates that in no instance does the CRBRP project-related traffic exceed capacities in the five road segments. With the exception of road segment 2, CRBRP project-related traffic would reduce traffic

Table A4.9 CRBRP project-related commuter traffic impacts on selected highway segments

Highway segment	Existing peak hour level of service	Existing level of service for hour which CRBRP commuter traffic contributes	Projected level of service for hour which CRBRP commuter traffic contributes
State Rt 58 Between I-40 and Bear Creek Rd (CBRRP Access Rd)	D	C	D
State Rt 58 Between Bear Creek Rd (CRBRP Access Rd) and ORGDP	D	B	D
State Rt 58 Between ORGDP and Intersection State Rt 95	D	B	C
State Rt 95 from Intersection State Rt 58 to Beginning of 4-Lane in Oak Ridge	E	C	D
State Rt 95 Between I-40 and Bear Creek Rd (CRBRP Access Rd)	E	D	E

conditions on all segments by one level of service. Traffic service on segment 2, which passes the Oak Ridge Gaseous Diffusion Plant, would be reduced by two levels. All segments except highway segment 3 would operate at low levels of service for approximately 2 consecutive hours during the peak commuting hours. The 2-hour duration results from the CRBRP project-related traffic immediately preceding the existing peak hour traffic, thereby extending the peak traffic period (ER Sec 8.3.2.1.3). Finally, levels of service would be the same for both inmovement conditions during the peak year of construction for the following reason: movers are expected to relocate in areas near the impacted highway segments and travel the same roads that they would were they not to relocate. Therefore, the number and distribution of automobiles is assumed to be relatively constant (ER App Sec 2.7).

The applicants' analysis provides the basic data for understanding how traffic would move from points of origin to the proposed CRBRP site. However, the staff believes that three additional social impacts must be considered. First, an increase in accident frequency and unlawful behavior (speeding, drunk driving) can be expected as by-products of increased road usage. Second, local residents using the regional highway network could be inconvenienced by increased traffic on local roads. During peak commuting hours, drivers may be subjected to periods of unstable traffic flow and stoppages of short duration. These inconveniences would occur during a relatively short, well-defined peak period in the work day, thereby affording local residents an opportunity to avoid CRBRP project-related

traffic through a rescheduling of activities. Third, increased use of local roads by commuting workers, trucks, and equipment could cause structural damage to these thoroughfares.

Health Care

Current relationships between health care facilities and providers and the population are summarized in ER Table 8.1-18. The applicants' analysis of the impact on health care during the peak construction period utilized U.S. Department of Health and Human Services standards* (HHS, 1977) to determine the number of hospital beds, physicians, and dentists that would be necessary to accommodate the project-related population under the two inmovement scenarios (ibid). Under the "worst case" assumption--40% of the workers move into the four-county impact area--20 hospital beds, 5 physicians, and 1 dentist would be required during the peak year of construction (ER App, Sec 2.3). Based on its review of this information, the staff agrees that these are reasonable figures.

Because the applicants' analysis does not account for current underutilization of facilities and services (hospitals in the four-county area are at most 76% occupied), the staff looked at changes to current relationships between services and people resulting from peak-year inmovement. Table A4.10 provides the results of the staff's analysis, which indicates that the impact of the inmoving population on the availability of health care services would be minor.

Municipal Water Supply

Current water sources, treatment capacities, and consumption rates for major water supply systems are indicated in Table 8.1-16 of the ER. Eleven of the 16 water systems listed are operating at 60% or less of system treatment capacity, and three are operating at 75% or less of capacity. Only two systems, First Utility District in Anderson County and Piney Utility District in Loudon County, are operating at capacity. However, both systems have entered into agreements with neighboring districts to provide additional water on a regular basis (ER Sec 8.1.3.3.1).

Overall, the utility systems in the four-county area have considerable underutilized capacity. One-half of the current excess capacity could supply the needs of an additional 150,000 people at a consumption rate of 150 gpd per person. This additional population far exceeds the expected residential population growth between 1981 and 1985 plus the inmovement of population under a worst case assumption.

Waste Disposal

Waste disposal includes both wastewater collection and treatment and solid waste collection and disposal.

The wastewater systems in the impact area are described in terms of treatment type, capacities, and average daily flows in ER Table 8.1-17.

*Four hospital beds and one physician per 1000 persons; one dentist per 1000 persons.

Table A4.10 Impact of inmoving construction workers on health care under alternative scenarios

County	Current			26% inmovement				40% inmovement			
	No./1000 population			No./1000 population				No./1000 population			
	Hospital beds	Physi- cians	Den- tists	No. of inmovers	Hospital beds	Physi- cians	Den- tists	No. of inmovers	Hospital beds	Physi- cians	Den- tists
Anderson	4.23	1.29	0.56	640	4.19	1.28	0.54	1010	4.17	1.27	0.54
Roane	3.63	0.66	0.43	800	3.58	0.65	0.43	1260	3.54	0.64	0.42
Knox	7.62	2.04	0.67	1450	7.59	2.03	0.67	2270	7.57	2.02	0.66
Loudon	1.75	0.46	0.39	320	1.73	0.45	0.38	500	1.72	0.45	0.38

Source: ER Table 8.1-18 and Section 8.1.3.4

All utility districts are operating well below treatment capacity except the Harriman district, which is operating at capacity. Of the 11 districts listed in ER Table 8.1-17, the capacities of six systems will be enlarged by 1985, including those in Rockwood, Kingston, and Harriman, which have the lowest differentials between average daily flow and treatment capacity (ER Sec 8.1.3.3.2). At 100 gpd per person, one-half of the existing capacity would be more than enough capacity to serve the anticipated growth of the resident population and the population associated with a 40% level of construction worker inmovement. Although excess capacity is available to accommodate projected growth, the distribution of growth may present problems. Most of the wastewater systems serve municipalities; in contrast, the rural areas are served by septic tanks and disposal fields. However, much of the land in rural areas is not suitable for these subsurface disposal systems.

Given the distribution of peak year project-related population, it seems unlikely that large numbers of in-movers would settle in areas unsuited for septic tank use to the point where collection systems would be required (ER Sec 8.1.3.3).

Anderson, Loudon, and Roane Counties operate their own landfills for solid waste disposal while Knox County utilizes contract hauling. The only landfill facility which is nearing capacity is the one used by Anderson County, and the county is taking action to have the capacity of that facility expanded. Each day approximately 525 tons of solid waste are collected and disposed of by the four jurisdictions (ER Sec 8.1.3.3.3). This number should be compared with the 10 tons that would be generated by in-moving population under the 40% migration assumption (ER App, Sec 2.6). The staff characterizes the solid waste generated by in-moving worker households as an insignificant incremental addition, approximately 1%, to the total waste currently disposed.

Public Safety

Table 8.1-19 in the ER provides information on the number and distribution of law enforcement officers and firemen in the four-county area. Considering the incremental and temporary nature of the work force inmovement and the small number of relocating workers in relation to the area's population, expansion of existing safety services would not be required (ER Sec 8.1.3.5.)

Recreation

Publicly supplied recreation facilities are listed and described in ER Table 8.1-20. Three of the four counties are served by full-time recreation and park agencies; Loudon County does not have a full-time parks and recreation staff, although the county does offer recreational facilities. In addition to publicly provided facilities and services, the four-county area offers opportunities for bowling, movies, hunting, and fishing.

The staff agrees with the applicants that recreational facilities in communities designated to receive in-movers will experience incremental demands on those facilities and services. Moreover, the increased usage of recreational facilities will be proportional to the number of persons that may temporarily move into a specific community. Despite increased usage, the staff concludes that the temporary nature of in-movers and their dispersed distribution will limit adverse impact on any community or county recreation program (ER Sec 8.3.2.15).

Visual Aesthetics

The proposed CRBRP would be located in a fairly isolated place and may be visible to the public from only a few vantage points. These points are mainly from the Gallaher Bridge (about 1.5 miles away), scattered residences on the opposite bank of the river, and portions of both I-40 and SR 58. The applicants have also indicated that the plant will not be visible from any significant off-site structure (applicants' response to Question 24, ER Am X).

The most noticeable visual feature would be the domed reactor containment structure, about 179 ft tall. The outer surface would be covered with a surfacing material harmonizing with other building finishes.

In the opinion of the staff, the proposed CRBRP would not form an objectionable visual intrusion on the landscape.

4.5.4 Economic Effects

Private Sector

The economic impact of construction of the proposed CRBRP on the surrounding area would be felt in both the private and public sectors. In general, the economic impact on the private sector would be beneficial. The direct project construction payroll is estimated by the staff to have a value of \$446.2 million (1981 dollars) through the construction period (Table A4.11). The tabulation shows that the payroll generated by induced (secondary) employment would add another \$2.5 million throughout the construction period. If a local expenditure rate of 40% is realized, this would be equivalent to a flow of \$179 million in the local economy, which would be of direct benefit to the private sector.

Public Sector

The economic impact on the public sector would depend upon the balance between tax revenues generated by the project and the need for increased public spending to provide tax-supported services to the primary and secondary work force. Table A4.12 lists some of the sources of tax revenue from the CRBRP as compared to the tax revenue situation of a comparable project financed by the private sector. The major differences are in the property and sales taxes and in the two Federal in-lieu-of-tax payments.

A public project would not be subject to either local property or sales and use taxes. These two taxes would represent the majority of public revenues attributable to a private project. On the other hand, DOE has the statutory authority to make financial assistance payments to affected jurisdictions and has expressed to NRC its intent to exercise this authority in the case of the CRBRP (see Appendix F).

Another source of Federal funds arises from Public Law 81-874. These funds are earmarked for support of schools in areas where Federal projects reduce the tax base. The amount of payment per pupil is based upon the category of the pupil (lives on Federal land/parent employed on Federal land, lives off Federal land/parent employed on Federal land, lives on Federal land/parent employed off Federal land). Appropriations for fiscal year 1982 are currently under Congressional review, and the future of such payments is in question.

Table A4.11 Direct and induced employment income (\$ millions)¹

Year after construction start	Direct income	Induced ² income	Total income
1	26.2	0.1	26.3
2	42.5	0.2	42.7
3	88.0	0.2	88.2
4	119.2	0.3	119.5
5	101.3	0.4	101.7
6	48.9	0.6	49.5
7	20.1	0.7	21.8
Total	446.2	2.5	448.7

Source: ER Tables 8.2-2 and 8.2-4

¹All dollar figures are in constant 1981 dollars.

²Based on average annual salary of \$8356.

Table A4.12 Tax revenues generated directly or indirectly from the proposed CRBRP compared to a hypothetical private project

Revenue source	Private project	CRBRP
Property tax	Yes	No
Sales and use taxes		
On materials consumed in construction	Yes	Yes
On materials that become a part of the building	Yes	No
Taxes generated by payroll spending		
Property taxes	Yes	Yes
Sales taxes	Yes	Yes
Miscellaneous (gas, liquor, cigarettes, etc.)	Yes	Yes
DOE in lieu-of-tax payments	No	Yes
PL 81-874 aid to schools	No	Yes

The inmovement of construction workers and their families would result in increased revenues to the general fund and school fund of local governments in the four-county area. The applicants estimated the property, sales, beverage, and miscellaneous tax benefits resulting from the inmoving population in the peak year of construction. These benefits are summarized in Table A4.13; a detailed analysis is in ER Appendix Section 3. The data emphasized major selected revenues from the peak influx of population and should only be used to provide insight into the relative magnitude of CRBRP's influence on local fiscal conditions. The inmovement of construction workers and their families would also create additional demands on public facilities and services. However, because the inmovement of population would be small relative to the existing resident population, the only service which might require expansion is education. The applicants compared the maximum requirement for additional teachers that might be needed in the school systems during the peak year of construction with local education revenues expected to be generated by new residents and found that such revenues should be sufficient to accommodate the increased costs of the required teachers. These data are provided in Table A4.14.

4.5.5 Summary of Socioeconomic Effects*

The forecasted effects of the CRBRP assumed two levels of inmoving construction labor which prevail under differing conditions of labor market completion. Extensive TVA construction work force experience was used to determine the specific levels of inmovement.

All of the inmoving workers were assumed to relocate to a four-county area surrounding the proposed CRBRP site. Knox County would receive 45% of the inmoving workers and their families, the largest portion of the inmoving population; Loudon County would receive the smallest percentage of inmoving population, 10%. Schools in western Knox County would experience an increase in existing overutilized conditions. The staff indicated that overutilization of county schools could reach 6% depending on the level of inmovement. Harriman and Loudon schools would have lower levels of overutilization coinciding with peak employment at the site. No school system would be faced with the need for capital expenditures, although additional teachers might be required in all systems.

The applicants' analysis of housing needs was based on a 50% requirement for conventional housing, 30% for mobile home sites, and 20% for apartments and rooms. Under certain conditions of housing supply, the communities of Oak Ridge, Lenoir City, and Kingston could be faced with tight housing markets. However, the effects in the housing market could have been overstated by the applicants because hotel/motel use and doubling up were not considered. Moreover, any adverse effect that does occur would last during a limited period and would end without any adverse, lingering effects for existing residents.

The existing level of service on four of five road segments evaluated would be expected to deteriorate by one level as a result of CRBRP project-related traffic. In the fifth segment, the deterioration would be two levels. However, in all cases the level of service prevailing when CRBRP project-related traffic would be on the road would be the same or higher than service at normal rush

*The discussion in FES Section 4.5.5 on visual effects is included at the end of Section 4.5.3 above.

Table A4.13 Selected revenues resulting from peak population influx during construction¹ (\$ thousands)

Location	Project-related general fund revenues ²	Project-related school fund revenues ³	Totals
Clinton	1,130	1,880	3,010
Oak Ridge	8,080	10,180	18,260
Lenoir City	1,400	2,090	3,490
Kingston	2,210	N/A	2,210
Rockwood	980	N/A	980
Harriman	560	2,980	3,540
Anderson County	4,370	7,290	11,660
Knox County	6,860	27,280	34,140
Loudon County	1,190	4,480	5,670
Roane County	2,680	10,170	12,850
Total	29,460	66,350	95,810

Source: ER Table 8.2-5.

Note: All figures are in 1981 dollars.

¹Twenty-six percent mover rate during estimated peak year of construction.

²Includes property tax, sales tax, beer and beverage tax, fines, fees, and charges.

³Includes property tax, sales tax, and state foundation and equalization funds.

hours. In fact, the most noticeable impact on traffic would be an extension of peak from 1 to 2 consecutive commuting hours during the peak of construction. The staff also noted the potential for increases in accident frequency, inconvenience, and accelerated road deterioration.

Water supply and treatment capacity are expected to be adequate to meet the demands of increased resident population growth and inmoving population. However, distribution and wastewater collection systems may require expansion or improvement in rural utility districts in the unlikely event that all in-movers choose rural locations.

Health care, public safety, and recreation are expected to receive additional demands but the increased demands are not expected to reduce the quality of existing service. Extensive mobile home development in areas not having adequate water systems could impose problems on the delivery of fire-fighting services.

The data indicate a \$446 million direct payroll throughout the construction period. If 40% of that payroll is spent in the four-county area, the private

Table A4.14 Expenditures and revenues for education related to peak population influx (\$ thousands)

School System	Cost/teacher*	26% inmovement				40% inmovement			
		Teachers needed	Peak yr cost	Peak yr revenues	Peak yr revenue-cost balance	Teachers needed	Peak yr cost	Peak yr revenues	Peak yr revenue-cost balance
Clinton	1,850	0	0	1,880	1,880	1	1,850	3,080	1,230
Oak Ridge	1,990	2	3,980	10,180	6,200	4	7,960	15,720	7,760
Harriman	1,400	0	0	2,980	2,980	2	2,800	4,890	2,090
Lenoir City	1,600	0	0	2,090	2,090	1	1,600	3,740	2,140
Anderson County	1,220	0	0	7,290	7,290	0	0	11,820	11,820
Knox County	1,660	8	13,280	27,280	14,000	12	19,920	43,230	23,310
Loudon County	1,490	1	1,490	4,480	2,990	2	2,980	6,950	3,970
Roane County	1,360	4	5,440	10,170	4,730	5	6,800	15,770	8,970

Source: ER, Table 3.13

*Based on FY 1981 financial documents.

NOTE: All figures are in 1981 dollars.

economy would receive a benefit of \$178 million. The benefit to the public sector would arise from sales taxes, taxes on property and beverages, and fees and fines. These revenues were compared with the maximum requirement for teachers in each school system; additional teachers were identified as the only probable item of expenditure by local government. In all instances, the revenues generated by the inmoving population would be more than sufficient to cover the local costs of increased educational expenditures.

4.5.6 Dust and Noise

The applicants have provided additional information since the issuance of the FES on construction-phase noise levels and their duration (ER Sec 4.1; Longnecker, 1982e). In an attempt to quantify these values for the various construction phases, the applicants have estimated--on the basis of the noisiest equipment expected to be operated on site during each phase--the noise pollution level (NPL) for each phase. The applicants' estimates of NPL for the various construction phases are within the ranges of values given in the literature for industrial and public works construction projects in an ambient acoustic environment typical of suburban residential areas.

The closest residences to the site are two, located across the river approximately 1000 m (3000 ft) from the center of the site. For the 0.8-km (0.5-mile) NPL estimates given by the applicants for site construction-related noise, the noise exposures are characterized by available criteria as "normally acceptable"--that is, reasonably pleasant for recreation and play in outdoor areas, and acceptable for all activities indoors. This characterization applies to all of the construction phases except foundation work. For this phase, construction noise exposures are estimated to be less, so that both indoor and outdoor environments at and beyond the 0.8-km (0.5-mile) distance would be characterized by available criteria as "clearly acceptable," that is, pleasant.

Factors affecting these characterizations of noise acceptability include the time and duration of exposure to site construction noise, deviation from normally experienced site-generated noise patterns, and impulse noises and their rate and time of occurrence. The factors are discussed below.

Noise generating construction activities at the site are projected by the applicants (ER Fig 4.1-6, Am XV) to continue throughout the day and evening hours (until about 11 pm), with two work shifts planned for all construction phases. No weekend work is currently scheduled, however. Unusual shift activities that may continue for a period of 24 hours include large concrete pours and the installation of special equipment. The overall period that nearby residents and transients would be exposed to construction noise is estimated to last approximately 5 years (site preparation and excavation, 1 year; foundation work, 9 months; plant erection; 3 years, 5 months; and site finishing; 1 year).

The applicants have identified some construction activities that, by necessity, will not conform to the above-mentioned schedule. These activities will be continuous and therefore will involve around-the-clock work activity. The cited activities include continuous concrete pouring for up to several weeks in the foundation and erection phases; reactor vessel installation over a 2-3-day period during the erection phase; and containment dome installation during a 1-week period in the erection phase.

Facility construction would also involve blasting throughout much of the construction period (the onsite quarrying operation is expected to last about 4 years). These activities, which are likely to have the greatest potential for causing offsite annoyance or activity interference, would be controlled and timed by the applicants to minimize their offsite effects (ibid). In addition to the use of small multiple charges for blasting, this activity, when necessary, would be scheduled for the first and second workshifts, to avoid disturbance during normal sleeping hours (see also Section 4.6.1.1(3) below).

These factors, along with the characterizations given earlier, provide the bases for staff conclusions that: (1) construction noise will be audible off site and at nearby residences throughout the construction period of about 5 years and (2) activity interference, including sleep interference, could occur during evening and nighttime hours, but only for residents and transient facility users within about 1.6 km (1 mile) of the site. This interference would most likely be limited to the site preparation and excavation phases of construction.

The potential for activity interference or annoyance from construction activities, other than blasting, at distances beyond about 1.6 km (1 mile) in southerly directions (across the Clinch River) is judged to be considerably less than those stated above because of (1) the presence of several intervening ridges in the topography of equal or greater height than the site area; (2) presence of forested areas on and beyond these ridges; and (3) the existence of other noise sources beyond the ridges (such as highways) that are likely to dominate noise levels in these areas.

The above information is cumulative and does not significantly change the staff's assessment of noise effects in the FES.

4.6 Measures and Controls To Limit Adverse Effects During Construction

For convenience of reference, this entire section of the FES is reproduced below, with appropriate updating changes.

4.6.1 Applicants' Commitments

The commitments made by the applicants to limit adverse effects during construction have been modified and expanded as shown below. Where such changes have been made, an asterisk appears beside the number of the item.

4.6.1.1 From the ER, Sections 4.1.1.8 and 6.1.4.3.4, Am I, Part II; ER Am XIII Table 4-4

- (1) Open burning will conform to state and Federal air pollution requirements.
- * (2) Disposal of wastes will conform to Tennessee Solid Waste Management Regulations.
- * (3) Blasting will be restricted to small multiple charges. Blasting would be scheduled during the first and second workshifts so disturbances would not be caused during the sleeping hours. Blasting during the major excavation of the "NI" generally will occur during the early part of the second shift, after the first shift has cleared the blasting area and

before the second shift enters. Blasting for other activities--such as quarry operations, trench excavations, and other miscellaneous yard structures--will occur at various times, depending on the location and size of the blasts and scheduling requirements.

- * (4) Encroachment upon the Hensley Cemetery will be avoided. (The use of a borrow pit has been eliminated and the Indian Mound has been removed.)
- * (5) In constructing the barge-unloading facility, river siltation would be controlled by building the facility on dry ground. (Some temporary turbidity increase and minor siltation will occur during final dredging.) Reclamation of land affected will consist of grading and returning topsoil, and seeding native grasses and other appropriate groundcover.
- * (6) Disposal of hazardous wastes and pollutants will conform to Federal and state regulations.
- * (7) Garbage generated during construction activities will not be burned. It will be discarded by a licensed contractor in regulated disposal facilities.
- * (8) Treated sanitary wastewater discharged to the river will meet standards of the Tennessee Department of Public Health. Chemical toilets will be used primarily during site preparation and resultant waste disposal will comply with approved practices.
- * (9) Erosion control measures are as specified in the Erosion and Sediment Control Plan. General erosion control will consist of leveling rutted areas, maintaining contours where possible, leaving tree stands where possible in the plant construction area, constructing drainage ditches at the base of stockpiles and excavation slopes, riprapping major diversion channels where erosive velocities are indicated, retaining drainage water in runoff treatment ponds before discharge to the river, developing a storm drainage system for site access roads and spoil laydown areas, landscaping as soon as construction schedules permit, providing mulch protection to seeding on slopes, and planting trees or other appropriate vegetation (see Section 4.4.2 for discussion of applicants' sedimentation and control plan).
- * (10) The site access road will be paved; onsite traffic will be controlled by the constructor.
- (11) Dust will be controlled by sprinkling roads and construction areas.
- * (12) Construction access roads will be restored to equal or better than original condition.
- * (13) Chemicals would not be used in clearing land, although maintenance of rights of way may involve localized applications of authorized herbicides. If herbicides are used, they will be applied only under certified supervision.

- *(14) Water discharged from runoff treatment ponds will meet the requirements that are incorporated in the NPDES Permit. (This replaces FES item 4.6.2.b.)
- *(15) Work schedules staggered with those of other plants will be established, if needed, to avoid unreasonable congestion on State Road 58 in Roane County. (This was FES item 4.6.2.c.)
- *(16) Prior to construction, the plant construction manager will be provided with locations of critical ecological elements. On-the-ground inspections of species and community locations will be made semi-annually and, if required, site preparation activities will be modified. (This replaces FES item 4.6.1.1(1).)
- *(17) Offsite transmission line rights-of-way have been coordinated with the State Historic Preservation Office, indicating that no significant potential for sites exists in the affected area. Should any significant site be revealed in or in the close vicinity of the corridor, relocation of the corridor, relocation of specific towers, or possible excavation will be considered and done in consultation with the State Historic Preservation Office and NRC.
- *(18) Dredging for the barge-unloading facility will be conducted during the August to March period unless there is evidence showing that those activities at other times would not adversely affect fish spawning. (This replaces FES item 4.6.1.1(2).)
- (19) A fire prevention and control plan has been developed and will be applied.
- (20) Siltation impacts will be reduced by dredging and constructing behind temporary dams for structures as specified in the approved Erosion Sediment and Control Plan.

Items 6, 8, 9, 13, 14, and 20 have been reviewed by EPA; NRC will defer to EPA for approval of or departures from these water-related commitments. It is the staff recommendation that the other commitments become conditions of any limited work authorization or the construction permit that may be issued for CRBRP.

4.6.2 Staff Evaluation

Based on its review of the anticipated construction activities and the expected environmental effects therefrom, the staff concludes that the measures and controls committed to by the applicants, as summarized above, are adequate to ensure that adverse environmental effects would be at the minimum practicable level with the following additional precautions:

- a. The applicants should set aside an appropriate buffer zone upslope of cover type vegetation on the north edge of the site (ER Sec 2.7.1.3.4) to ensure their preservation and protection during the construction period.
- b. Dredging, cofferdam construction, and fill deposition in the Clinch River should not coincide with striped bass use of the Clinch River as a thermal

refuge or when sauger are spawning, unless there is evidence showing that these activities would not adversely affect the two species. (This replaces FES item 4.6.2.d; FES item 4.6.2.b was deleted as unnecessary.)

- c. Local costs for additional public services needed by construction workers and other project personnel and their families would probably not exceed the local benefits from the project. The staff's opinion is that the only reliable way to establish the balance between local costs and benefits caused by CRBRP construction is for a monitoring program to be established. The results of this program should be made available to the State of Tennessee and affected local government entities, and negotiations should be conducted with them so agreement can be reached on financial assistance and/or other suitable measures to mitigate adverse impacts of the project.

The above requirements have been updated to make them current and more explicit. No significant changes in environmental impacts predicted in the FES are anticipated.

5 ENVIRONMENTAL IMPACTS OF PLANT OPERATION

5.1 Land Use

No change in expected effects on land use has occurred. The sentence in the first paragraph stating that the "dedication of the land as a plant site represents an improved use of the land which is presently forested" has been deleted.

In the second paragraph, the sentence beginning "Indian artifacts...." has been deleted.

5.2 Water Use

Primarily because of changes in the cooling system design, plant operation at full power would require an increase from 3584 gpm (8 cfs) to 3733 gpm (8.3 cfs) in the annual average use of water. This increase is not environmentally significant.

Chemical and sanitary sewage discharges would be regulated by the NPDES Permit and the State of Tennessee 401 Certification (see Appendix H).

5.3 Heat Dissipation System

5.3.1 Water Intake

The material in this section of the FES has been reorganized for clarification, and some new information from recent intake studies is presented. FES Figure 5.1 and FES Table 5.1 have been deleted because the pertinent data are now included in the text. EPA has tentatively determined that the location, design, construction, and capacity of the proposed intake reflect the best technology available for minimizing adverse environmental impacts in accordance with Section 316(b) of the Clean Water Act (NPDES Permit Rationale, Part II.H).

5.3.1.1 Impingement

The intake system would consist of two perforated pipes submerged in the Clinch River several feet above the bottom. (A description of the two pipes is in Section 3.4.2.) Several characteristics of the system should result in reduced fish impingement: (1) low intake velocity, with the maximum average velocity of entering water measured 0.75 in. from the surface of the perforated pipe estimated to be less than 0.4 fps, and with normal estimated velocities of less than 0.2 fps; (2) orientation of the perforated pipes parallel to the shoreline, thus facilitating passage of debris and aquatic biota past the structures; (3) uniform velocities through the perforations due to internal sleeving of pipes; (4) low approach velocities; and (5) elimination of need for trash racks, vertical traveling screens, and intake canals (ER Sec 3.4 and 10.2).

Organisms that cannot withstand the intake currents surrounding the perforated pipes and that are not large enough to pass through the perforations will be

impinged on the intake pipe. Such susceptible organisms would be principally large fish larvae and weakened or stressed juvenile and adult fish. The ability of a fish to maintain its position in water currents varies with species, size, water temperature, dissolved oxygen, and the physical condition of the organism. Smallmouth bass fry (Micropterus dolomieu) 20-25 mm long have sustained swimming speeds ranging from 0.16 to 1.02 fps depending on water temperature (Larimore and Duever, 1968). Striped bass (Morone saxatilis) approximately 25-40 mm long can maintain themselves in currents of 1 fps (Kerr, 1953). For most freshwater fishes, the darting speed is almost 10 times the body length per second (Gray, 1957).

Impingement of threadfin shad on the perforated pipes could occur during the winter as a result of cold stress when ambient water temperatures get below 54°F (Griffith and Tomljanovich, 1975). Low water temperatures can cause loss of equilibrium and eventual death. Shad in the moribund or weakened state would be susceptible to any flow rate, and large numbers could become impinged. Back washing of the perforated pipes would release these organisms. Impingement of severely debilitated threadfin shad would hasten their death; however, the impact this might have on the fish community would be undetectable because a majority of the Watts Bar population would be cold stressed and likely to die even without becoming impinged.

A potential problem with the intake system is the clogging of intakes by the Asiatic clam, Corbicula sp. Dead spaces and areas of very low velocities within the perforated pipes may cause Corbicula sp. larvae to settle out and clog the pipes. Partial obstruction of the pipes and perforations would tend to slowly increase approach and intake velocities and increase the potential for greater impingement and entrainment losses. Normal intake pipe maintenance would include back flushing, in-place scrubbing by scuba divers, and removal of sections for major repair. During the first year of operation at least one routine inspection of the water intake would be made by scuba divers (timed for Corbicula sp. infestations). One or more sections of the pipe would be removed and inspected (ER Am I, Part II, C17 through C19). The staff concludes that the applicants' maintenance plans are adequate to prevent any significant adverse effects to the intake structures.

The staff concludes that the design and operation characteristics of the intake structure the small volume of water in relation to the river flow being withdrawn through the intakes and the known swimming speeds of the various species of local fishes preclude the possibility of any significant impact to the Watts Bar fishery. This conclusion is further supported by the results (WPPS, 1980) of intake inspection studies conducted at the Washington Public Power Supply System Unit 2 Nuclear Station, which is located in the State of Washington on the Columbia River and which has an almost identical perforated pipe intake structure. The results showed that no fish were impinged during the inspection periods. During this test, the velocities at the intakes were maintained at near-operational levels.

5.3.1.2 Entrainment

Phytoplankton, zooplankton, drift invertebrates, ichthyoplankton (fish eggs and larvae), and other organisms incapable of avoiding the intake velocities and yet small enough to pass through the 9.5-mm (3/8-in.) pipe perforations would be subject to passage through the plant cooling system (entrainment). Entrained organisms would be exposed to a sudden maximum temperature rise of about 16.7°C

(30F°) across the condensers. In addition, they would experience the physical and chemical stress of pumping and passing through the cooling tower before return to the river. Because most entrained organisms would be killed, the staff assumes 100% mortality for all entrained organisms.

Because of flow manipulation at the Melton Hill Dam, the Clinch River in the vicinity of the site has in the past experienced about 17 days of no flow per year. The number of phytoplankton, zooplankton, drift invertebrates, and fish eggs and larvae available for entrainment depends on the number in the immediate vicinity of the perforated pipes. The number available for entrainment under lotic conditions is greater than in a lentic environment because the flowing of water would move eggs and larvae from upstream to the vicinity of the intake. Under lentic conditions, localized depletion of organisms would occur; however, the total number lost to the system would probably be less than in the reverse condition. The staff, therefore, performed its analysis of impact for the more conservative lotic conditions.

The entrained phytoplankton, zooplankton, drift invertebrates, and ichthyoplankton all would suffer about 100% mortality. Based on the fraction of total river flow withdrawn by the plant using the lowest average monthly flow of 3716 cfs for May and the maximum water makeup of 22.3 cfs, the average loss would be 0.6% of the entrainable organisms, assuming a uniform distribution of organisms throughout the water column. Under low flow conditions of 1000 cfs, the loss would be only 2.2%. Even if the entrainable organisms are found to be in higher concentrations in the vicinity of the intake, a doubling or tripling of the number of organisms entrained would probably not have a significant effect on the aquatic ecosystem in the vicinity of the plant.

Based on the results of studies conducted by the applicant (Loar et al., 1981; Cada and Loar, 1981; and Scott, 1980), the intake structure would not be located in a stretch of river that is uniquely important for the spawning or early life history of any species of fish. It is concluded that the anticipated impact to Clinch River and Watts Bar Lake fisheries due to impingement or entrainment would be minor and undetectable.

The results of the above analysis do not constitute a significant change in the FES assessment.

5.3.2 Water Discharge

5.3.2.1 Thermal Plume Characteristics

New design parameters for the plant cooling system have arisen as a consequence of the selection of the turbine generator and refinements in cooling tower design. The result is that small increases (less than 5% in the size of the extended no-flow plumes would be expected (ER Sec 5.1.1.1.1, Am IX). Another change is that river flow rates are slightly higher, based on a longer data record (ER Table 2.5.3). This new information leads to very small changes, so that the staff considers its analysis of the thermal plume in the FES to be still valid. In FES Figure 5.2, the applicants' reanalysis shows that the thermal plumes, bottom, are changed to 1.2F° and 0.9F° from 1.25F° and 0.9F°, respectively.

The above changes are not environmentally significant.

5.3.2.2 Thermal Plume Effects

The material regarding thermal plume effects has been revised primarily for clarification and to provide consideration of more recent information (Section 2.7.2) on striped bass.

The plant's thermal discharge would not have a detrimental effect on phytoplankton, zooplankton, ichthyoplankton, juvenile fishes, or macrobenthic drift. Temperature increases in the plume will be small and within the thermal tolerance limits of most of the dominant species present in the river. Under normal operation the plume size would be small in relation to the river so only a small portion of the planktonic organisms drifting past the site would experience temperatures elevated more than a few degrees. Furthermore, the small size of the plume minimizes the time the organisms are exposed to the elevated temperature. The rapid regeneration rates of phytoplankton and zooplankton could compensate for decreases due to plant operation.

Ichthyoplankton are more sensitive to temperature differences than most other planktonic organisms. Fish egg temperature tolerances are generally lower than those for larvae or adults (Levin et al., 1970). Most fish in the plant vicinity have demersal and adhesive eggs not normally found in the water column. The loss of fish eggs due to plume entrainment and subsequent mortality due to elevated temperatures are expected to be insignificant.

Larvae and juveniles of most fish species in the vicinity of the plant would avoid open areas and areas of high flow, preferring backwaters, shorelines, and the portion of the water column nearest the bottom. This behavior lessens significantly the number that potentially could be entrained in the discharge plume. Ichthyoplankton presence in the river is seasonal (usually April through August with highest densities in late spring and early summer) and consequently would not be subject to the winter thermal regimes, which are the most severe.

Temperatures above 30°C (86°F) are not suitable for many macrobenthic invertebrates (Jensen et al., 1969). However, the 25.6°C (78°F) maximum river temperature recorded in the plant vicinity plus a ΔT of 3.4°C (6.1°F) gives a potential maximum temperature of 29°C (84.1°F), below temperatures reported harmful for most organisms.

The scouring of periphyton and benthic organisms by the discharge plume is predicted to be confined to about 100 ft² of river bottom and, therefore, insignificant. Typical bottom temperatures are predicted to be 0.7°C (1.2°F) above ambient over less than 450 ft² of bottom. Even under extended no-flow conditions during the winter, elevated temperatures on the order of a few degrees would affect only several acres of river bottom. Because daily ambient temperature variation in the water column can be as great as 1 to 1.5°C (2 to 3°F), no impact due to the thermal discharge on periphyton and benthic organisms is predicted.

During typical summer conditions, temperatures lethal to fish could potentially be reached at the effluent discharge point and in the extremely small area around it, but fish would need to remain in the near vicinity of the effluent discharge for an extended period of time before they would suffer mortalities from the elevated temperatures. Their ability to maintain themselves in that

area for long periods is questionable because of the high current velocity (15 fps) of the plant discharge.

Fish are able to detect and avoid temperature gradients in both vertical and horizontal planes and generally will avoid lethal temperatures (Alabaster, 1969). Freshwater fish can detect temperature differences of less than 1°C (Levin et al., 1970). At Lake Monona, WI, fish avoided a power plant thermal discharge area when temperatures reached 35°C (98°F); however, several species of fish maintained themselves at selected temperatures within the mixing zone (Neill, 1970). The majority of 70 Lake Michigan fish collected from a discharge plume had body temperatures lower than that of the discharge water (Spigarelli et al., 1974). The investigators concluded that the fish were regulating their movements between the warm and cool areas around the heated effluent or just recently had moved into the heated water area. The staff concludes that, although temperatures lethal to the species found in the Clinch River will be present during the summer, under normal flow conditions fish will avoid these areas and mortality due to the thermal discharge would be nonexistent.

During an extended period of no release from Melton Hill Dam during the late summer, the surface near the southwest bank at CRM 16 would be elevated approximately 0.72°C (1.3°F) above ambient (ER Sec 5.1.3.1). The 0.56°C (1°F) isotherm would extend for over 0.75 mile in either direction, affecting a large area of the Clinch River. The effect of this increased temperature on warm water species inhabiting the Clinch, even during the highest recorded ambient water temperature, would be insignificant. FES Table 5.8 lists the estimated effects of increasing water temperatures on the fish community of the Tennessee River (Bush et al., 1972). With a 25.6°C (78°F) maximum reported ambient river temperature and a ΔT of 0.72°C (1.3°F), the maximum temperature of a significant portion of the top 1 m (3 ft) of water would not be detrimental to any native warm water species known to inhabit the Clinch in the vicinity of the plant. The striped bass, a cool-water introduced species, however, may be adversely affected by concurrent plant operation and an extended no-flow condition in the Clinch River. The striped bass utilize the Clinch River in the vicinity of the station as a late summer, early fall thermal refuge (see Section 2.7.2).

A large portion of the area extent of the thermal refuge and the portion of the water column inhabited by the fish would probably be subjected to increased temperatures. Depending on the ambient conditions of the river, such temperatures could approach or exceed lethal limits. The exact location of the striped bass in the upper Clinch River is not known with certainty; therefore, the magnitude of this effect cannot be predicted. However, the frequency of occurrence of extended no-flow conditions in the Clinch River has been low, particularly in recent years.

In summary, the staff judges the impacts from the thermal discharge upon aquatic biota for all species, during normal operation and with flow in the Clinch River, to be insignificant. Because of the small size of the plume, the small rise in temperatures, high river flow rates, the small quantity of water discharged (5 cfs), and the short time organisms are exposed to the plume, the impact from the thermal discharge would not produce a significant change on the aquatic ecosystem.

During periods of no river flow and plant operation, impacts to species other than striped bass are expected to be insignificant and undetectable. Striped bass may be detrimentally affected under these conditions during late summer and early fall. The lack of specific information on the location and densities of fish in the vicinity of the plant site precludes a precise assessment of potential impact to the Watts Bar striped bass population. The NPDES Permit III.M. requires the following:

Permittee shall conduct studies to assure that thermal discharges will have minimal impact on striped bass (Morone saxatilis) during extended summer periods of zero flow as described in Section 4.1.2 of the "Update to the CRBRP Alternative Siting Analysis Within the TVA Power Service Area" (dated May 28, 1982).

Permittee shall not start construction of the plant discharge structure prior to submittal of reports on these studies (see Part III.P.) and receiving approval by the Director, Water Management Division to start such construction. Such studies and reports shall include (1) coordination with TVA studies on lethal temperatures for adult and juvenile striped bass, (2) statistical analysis of streamflow during the months of July through September, (3) reevaluation of the thermal plume dispersion, and if necessary, (4) a review of alternative diffuser designs and thermal modeling. In the event that the above studies fail to demonstrate that the CRBRP thermal discharge will have no significant impact on the striped bass thermal refuge, this NPDES permit shall be modified to impose more stringent limitations on plant discharges.

The applicants have formally committed to these precautionary measures to protect the species (Longenecker, 1982d). The staff, however, does not expect impacts to striped bass to occur because future periods of no river flow are unlikely (Section 2.5.1).

5.3.2.3 Cold Shock

No change is necessary in this section of the FES.

5.3.2.4 Scouring

No changes have been made to this section of the FES.

5.3.3 Atmospheric Heat Transfer

No changes have been made to this section of the FES.

5.3.4 Threatened and Endangered Aquatic Species

(This is a new section; however, the last paragraph of FES Section 2.7.2 should be noted.)

The FES (Section 2.7) addressed rare and endangered species. However, in compliance with Section 7 of the 1978 Amendments to the Endangered Species Act,

the NRC asked the U.S. Fish and Wildlife Service (FWS) to provide a current list of those Federally recognized threatened and endangered species (including species listed, proposed to be listed, and under status review) as well as designated critical habitats, which might be affected by the licensing of the CRBRP (Check, 1981). The FWS response (Hickling, 1981) listed 1 species of fish and 11 species of freshwater mussels (Appendix B). No critical habitat has been designated in the vicinity of the site. The FWS requested, under a provision of the Endangered Species Act, that the NRC perform a biological assessment for each of the listed species.

The staff conducted a preliminary analysis and has concluded that the species of fish Hybopsis cahnii is not present at the site; therefore, no potential for impact exists.

In May 1982 TVA conducted a comprehensive freshwater mussel survey in the vicinity of the proposed CRBRP site. The methodology and results of the survey are given in Section 2.7.2. Only one Federally protected species, Lampsilis o. orbiculata, the pink mucket pearly mussel, has been taken recently from the Clinch River near the site. The live specimen was collected approximately 1 mile upstream of the site boundary. The 1982 mussel survey that examined transects adjacent to as well as upstream and downstream of the site failed to find additional live specimens of this or any other Federally protected species. Area surveys conducted in the immediate vicinity of the proposed intake, discharge, and barge-unloading facilities also resulted in no additional specimens.

The staff has conducted a preliminary analysis on the potential impact of CRBRP operation on L. o. Orbiculata in the Clinch River at and downstream of the site and has tentatively concluded that no significant impact would occur. The design of the discharge and the low discharge flow would minimize bottom scouring. The thermal and chemical plume would only infrequently intersect the river bottom and then only in a small area.

The staff completed an endangered species assessment and submitted it to the Fish and Wildlife Service for approval in August 1982. In that assessment the staff concluded that construction and operation of the CRBRP will not have an adverse effect on any Federally protected endangered or threatened species. By letter dated September 17, 1982, FWS advised the NRC that it concurred in the staff conclusions.

The only species declared endangered or threatened by the State of Tennessee that is not Federally recognized and that may occur in the vicinity of the site is the blue sucker, Cycleptus elongatus. FES Section 2.7.2 summarizes the known captures of this species in Watts Bar Lake. No significant losses to this species as a result of thermal impact, impingement, or containment are anticipated.

5.4 Other Nonradiological Effects

All nonradiological discharges from the plant are expected to comply with standards of performance for new sources (40 CFR 423.15 and 423.45) and Tennessee Water Quality Standards requirements (see Appendix H).

5.4.1 Impacts of Chemical Effluents

The maximum release of total residual chlorine is now limited to 0.14 mg/l, a decrease from the 0.5 mg/l maximum concentration estimated in the FES. This more stringent limit has been established by EPA to avoid significant impacts on aquatic biota and is included in the NPDES permit (NPDES 011). The discharge design will ensure a dilution of 13 to 1 within 20 m (66 ft) of the discharge point (draft NPDES Permit Part III.D).

Except for copper, individual constituents of the discharge will be in compliance with water quality criteria and effluent limitations (see also response to NRDC comments 25a, b, and c in Section 12.3.5.3). Because of the presence of ambient data at the site that indicate that copper exceeds or potentially exceeds the toxic substances clause of the Tennessee Water Quality Standards, Special Conditions III.P, III.Q, and III.R have been incorporated into the draft NPDES Permit. Parts III.P and Q require that the applicants conduct a sampling and analysis program for both total and dissolved copper and submit an assessment ensuring their ability to comply with Tennessee Water Quality Standards requirements. This report will include an assessment of alternatives, remedial actions, and an implementation schedule to provide corrective actions, if necessary, prior to plant operation. Additionally, Part III.R requires the applicants to conduct appropriate toxicity screening tests on the actual plant effluent to ensure that Tennessee Water Quality Standards requirements are met. Approval of the testing methods and procedures as well as evaluation of results will be coordinated with the State of Tennessee.

5.4.2 Sanitary and Other Waste

In the second paragraph, the material following the first sentence has been revised and replaced as follows:

Gaseous emissions from emergency generators and firepumps are regulated by the Tennessee Department of Health, Division of Air Pollution Control. These units appear to comply with state limitations; however, a state permit has not yet been issued. The limit for nitrogen oxide does not apply because the total fossil-fueled heat input rate of 159 million Btu/hr is less than the regulatory threshold of 250 million Btu/hr. Regulations limit the sulfur dioxide emission rate and the particulate emission rate to 5 lbs and 0.13 lbs per million Btu of heat input, respectively. The diesel units are well within this limit. Carbon monoxide emissions are not regulated. The state air permit may include a limitation on organics when issued.

5.5 Transmission Lines

The applicants' plan to control vegetation growth now calls for mechanical cutting every 4 or 5 years and limited use of approved herbicides (ER Am I, Part II, B2).

5.6 Community Impacts

The following updated discussion replaces that in the FES:

The socioeconomic impacts during the operating period arise primarily from absorption of the work force members and their families into the existing community. The applicants now estimate that CRBRP will operate with approximately 250 personnel, including the security force hired locally. In addition, the number of people associated with the CRBRP project office will rise to about 240 during the peak year of construction, then taper down to 140 people in the first operating year and 25 in the sixth year of operation (ER Table 8.2-1). The applicants indicate that 75 jobs would be created as a result of the direct employment on CRBRP (ER Table 8.2-3). In the staff's judgment, a higher fraction of the direct workers will be in-movers than was the case for the construction labor force because of the specialized nature and long-term stability of the work.

However, as indicated by the applicants' estimates, operating work force impacts to an extent will have taken place during the construction period. About 70 operating workers would be on site during the peak year of construction and the number of such workers would increase to 280 during the last year of construction (ER Table 8.2-1). With respect to induced employment, the staff's judgment is that such positions would be filled by people entering the labor force, internal shifts in the labor force, by reductions in unemployment, and by spouses of in-moving operation workers.

In order to determine the maximum net possible impact of operating phase workers on housing and schools, the staff considered the 180 operations personnel (the difference between the 250 operations phase workers and the about 70 such workers who would be present during the construction phase) as the primary source of social impact. The staff conservatively assumed that these operating personnel would all be in-movers, would all be married, and would have 1.2 children per household, of which 0.7 would be school age (see ER Table 8.3-2). These conditions result in a total population influx of approximately 580 people, including 126 children of school age. Table A5.1 shows the expected distribution of operating personnel and school-age children. For each community the number of operating personnel and school-age children to be accommodated is less than the number of in-movers expected during the construction phase. Because of the small numbers of people involved and their dispersion throughout the area, the staff believes no one jurisdiction would have difficulty in accommodating operating phase in-movers.

The payroll impact of the total operating staff is estimated by the applicants to be \$5.1 million per year in constant 1981 dollars. For the 30-year life of the plant, the direct payroll effect would be \$153.2 million in constant 1981 dollars (ER Sec 8.2.2.1).

5.6.1 Taxes

The project would neither contribute directly to the tax base of the local area through the payment of property (plant and land) taxes, nor would it detract from current revenues. That leaves three possible revenue sources by which the project would help meet the increased public spending load in the local area as

Table A5.1 Geographic distribution of
CRBRP operating personnel
and school-age children

Location	Households	School-age children
Anderson County	9	6
Oak Ridge	27	19
Knox County	80	56
Loudon County	19	13
Roane County	45	32

Source: Percentage distribution from
ER Table 2.1-4.

a result of operation of the project: direct and indirect taxes from payroll and spending, DOE in-lieu-of-tax payments, and PL 81-874 payments to schools.

Taxes from Payroll Spending

Local communities now can add to the state sales tax of 4.5% on designated items an additional tax of up to 2.25% which is returned to the counties and often used for school system support.

The applicants estimate the value of local revenues derived from workers at approximately \$89,000 (1981 dollars) for a typical operating year (Longenecker, 1982a). Revenues included in this estimate are those paid as a result of local property taxes, sales taxes, beverage taxes, fines, fees, and state transfer funds.

In-Lieu-of-Tax-Payments

In the case of CRBRP, DOE now has the authorization to make financial assistance payments to Roane County, Anderson County, and the City of Oak Ridge.

PL 81-874 Payments

This program provides Federal aid to school districts when schools are adversely impacted by concentrations of Federal employment. However, since the FES was written, PL 81-874 has come under Congressional review and its future is in question.

5.7 Radiological Impacts from Routine Operations

Changes to this section are: (1) revised dose estimates from exposure to airborne effluents based on revised meteorological dispersion factors and estimates

of airborne releases; (2) revised dose estimates from exposure to liquid effluents based on revised aquatic dilution factors and estimates of liquid effluents; (3) revised dose estimates from the CRBRP fuel cycle based on more conservative estimates of the quantities of radionuclides released; and (4) inserts concerning potential health impacts from occupational and offsite exposure to radiation. The conclusions relative to these modifications are essentially unchanged from those in the FES.

5.7.1 Radiological Impacts on Biota Other Than Humans

The following material replaces that in Section 5.7.1 of the FES (The conclusions are essentially the same.):

Depending on the pathway and radiation source (FES Fig. 5.5), terrestrial and aquatic biota will receive doses that are approximately the same or somewhat higher than humans receive. Although guidelines have not been established for acceptable limits for radiation exposure to species other than humans, it is generally agreed that the limits established for humans are sufficiently protective for other species.

Although the existence of extremely radiosensitive biota is possible and increased radiosensitivity in organisms may result from environmental interactions with other stresses (for example, heat or biocides), no biota have been identified as showing a sensitivity (in terms of increased morbidity or mortality) to radiation exposures as low as those expected in the area surrounding the proposed CRBRP. Furthermore, at all nuclear plants for which radiation exposure to biota other than humans has been analyzed (Blaylock, 1976), there have been no cases of exposure that can be considered significant in terms of harm to the species, or that approach the limits for exposure to members of the public that are permitted by 10 CFR 20 (1981). Inasmuch as the 1972 BEIR Report (BEIR I) (Nat'l Acad Sci, 1972) concluded that evidence to date indicated that no other living organisms are very much more radiosensitive than humans, no measurable radiological impact on populations of biota is expected as a result of the routine operation of CRBRP.

5.7.2 Radiological Impact on Humans

5.7.2.1 Exposure Pathways

The staff's evaluation provides dose estimates that can serve as a basis for a determination that releases to unrestricted areas are as low as practicable in accordance with 10 CFR 50 and within the limits specified in 10 CFR 20.

Estimates of radiation doses to humans at and beyond the site boundary via the most significant pathways among those diagrammed in FES Figure 5.6 were made using models described in Regulatory Guide 1.109, Revision 1 (October 1977).

5.7.2.2 Liquid Effluents

In the first paragraph of Section 5.7.2.2 in the FES, the first sentence has been modified to read: "Expected radionuclide releases in the liquid effluent

were calculated for the plant and are listed in Table 3.3, as amended in Section 3.5 of this supplement."

The potential individual doses from liquid effluents are summarized in Table A5.2, which replaces FES Table 5.11.

Table A5.2 Annual individual doses from exposure to liquid effluents from CRBRP

Location	Pathway	Dose, mrem/yr			
		Total Body	GI Tract	Thyroid	Bone
Coolant discharge region	Fish ingestion (21 kg/yr)	<0.01	<0.01	<0.01	<0.01
	Beef ingestion (110 kg/yr)	<0.01	<0.01	<0.01	<0.01
	Swimming (100 hrs/yr)	<0.01			
	Boating (600 hrs/yr)	<0.01			
	Shoreline activities (500 hrs/yr)	<0.01			
	Milk* ingestion (330 l/yr)	<0.01	<0.01	0.08	<0.01
Oak Ridge Gas Diffusion Plant intake	Water ingestion (370 kg/yr)	<0.01	<0.01	<0.01	<0.01

*These dose rates are for an infant.

In the first paragraph of this section of the FES, the third sentence has been modified to read: "Under the same conditions the tritium concentrations would be much less than 10 pCi/ml.

In the second paragraph of this section in the FES, the third sentence has been modified to read as follows: "The total body dose to a hypothetical individual who receives all drinking water from the plant discharge region of the Clinch River was estimated to be less than 0.1 mrem/yr."

The third paragraph of this section has been modified to read:

Other pathways of relative importance involve recreational use of the river in the vicinity of the discharge zone. Potential individual doses from consuming fish or invertebrates caught in the immediate discharge area were evaluated using the biological accumulation

factors listed in Regulatory Guide 1.109. Humans are not expected to consume Clinch River invertebrates. However, if someone does consume 5 kg/yr of invertebrates caught in the discharge region, the dose rate would be less than 0.1 mrem/yr to the total body. Potential individual doses from swimming, boating, and shoreline recreation in the discharge region were also evaluated. Table A5.2 summarizes the potential individual doses from liquid effluents. The radionuclides primarily responsible for the quoted doses are tritium, cesium, strontium, cobalt, and tellurium. In all cases, the plutonium radioisotopes would contribute less than 1% to the quoted doses.

5.7.2.3 Gaseous Effluents

Radioactive effluents released to the atmosphere from the plant would result in small radiation doses to the public. Staff estimates of the probable gaseous releases listed in FES Table 3.4 as amended in Section 3.5 of the supplement were used to evaluate potential doses. All dose calculations were performed using annual average site meteorological conditions and assuming that releases would occur at a constant rate. Doses resulting from near-ground releases of radioactive gases were calculated by considering immersion in the gases, inhalation of the gases, and ingestion of food from pathways exposed to the gases (Regulatory Guides 1.111 and 1.109). Doses to a maximally exposed individual at the site boundary as a result of gaseous effluents are summarized in Table A5.3, which replaces FES Table 5.12. The changes shown in the new table are not environmentally significant.

Table A5.3 Annual individual doses due to exposure to gaseous effluents from CRBRP at site boundary*

Pathway	Dose, mrem/yr		
	Total Body	Skin	Thyroid
Plume	0.34	2.3	0.34
Inhalation	<0.01	<0.01	<0.01
Vegetable, meat, and milk food chains	0.02	0.02	0.02

*0.44 miles NW, $\chi/Q = 1.2 \times 10^{-4}$ sec/m³.

5.7.2.4 Direct Radiation from the Facility

No changes have been made to the plant design that would significantly affect the environmental impacts considered in this section of the FES.

5.7.2.5 Occupational Radiation Exposure

The following discussion is provided as an addition to this section of the FES.

The average annual dose of about 0.8 rem per nuclear plant worker at operating BWRs and PWRs has been well within the limits of 10 CFR 20 (NUREG-0713). In

Table A5.4 Incidence of job-related mortalities

Occupational Group	Mortality Rates (premature deaths per 10 ⁵ person-years)
Underground metal miners*	~1300
Uranium miners*	420
Smelter workers*	190
Mining**	61
Agriculture, forestry, and fisheries**	35
Contract construction**	33
Transportation and public utilities**	24
Nuclear-plant worker***	23
Manufacturing**	7
Wholesale and retail trade**	6
Finance, insurance, and real estate**	3
Services**	3
Total private sector**	10

*The President's Report on Occupational Safety and Health, "Report on Occupational Safety and Health by the U.S. Department of Health, Education, and Welfare," E. L. Richardson, Secretary, May 1972.

**U.S. Bureau of Labor Statistics, "Occupational Injuries and Illness in the United States by Industry, 1975," Bulletin 1981, 1978.

***The nuclear-plant workers' risk is equal to the sum of the radiation-related risk and the nonradiation-related risk. The occupational risk associated with the industry-wide average radiation dose of 0.8 rem is about 11 potential premature deaths per 10⁵ person-years due to cancer, based on the risk estimators described in the following text. The average non-radiation-related risk for seven U.S. electrical utilities over the period 1970-1979 is about 12 actual premature deaths per 10⁵ person-years as shown in Figure 5 of the paper by R. Wilson and E. S. Koehl, "Occupational Risks of Ontario Hydro's Atomic Radiation Workers in Perspective," presented at Nuclear Radiation Risks, A Utility-Medical Dialog, sponsored by the International Institute of Safety and Health in Washington, D.C., September 22-23, 1980. (Note that the estimate of 11 radiation-related premature cancer deaths is potential rather than actual.)

Table A5.4, the staff has estimated the risk to nuclear power plant workers and compared it to risks that are published for other occupations. Based on these comparisons, the staff concludes that the risk to nuclear plant workers from plant operation is comparable to the risks associated with other occupations.

In estimating the number of health effects resulting from both offsite (see Section 5.7.3) and occupational radiation exposures due to normal operation of

CRBRP, the staff used somatic (cancer) and genetic risk estimators based on widely accepted scientific information. Specifically, the staff's estimates are derived from the National Academy of Sciences' Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR I). The estimates of the risks to workers and the general public are based on conservative assumptions (that is, the estimates are probably higher than the actual number). The following risk estimators are used to estimate health effects: 135 potential deaths from cancer per million person-rem and 258 potential cases of all forms of genetic disorders per million person-rem. The cancer mortality risk estimates are based on the "absolute risk" model described in BEIR I. Higher estimates can be developed by use of the "relative risk" model, along with the assumption that risk prevails for the duration of life. Use of the "relative risk" model would produce risk values up to about four times greater than those used in this report. The staff regards the use of the "relative risk" model values as a reasonable upper limit of the range of uncertainty. The lower limit of the range would be zero because health effects have not been detected at doses in this dose-rate range. The number of potential nonfatal cancers would be approximately 1.5 to 2 times the number of potential fatal cancers (BEIR III).

Values for genetic risk estimators range from 60 to 1500 potential cases of all forms of genetic disorders over all future generations per million person-rem (derived from BEIR I). The value of 258 potential cases for all forms of genetic disorders is equal to the sum of the geometric means of the equilibrium values of the risk of specific genetic defects and the risk of defects with complex etiology.

The preceding values for risk estimators are consistent with the recommendations of a number of recognized radiation protection organizations, such as the International Commission on Radiological Protection (ICRP, 1977), the National Council on Radiation Protection and Measurement (NCRP, 1975), the National Academy of Sciences BEIR III Report (Nat'l Acad Sci, 1980), and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR, 1977).

The risk of potential fatal cancers in the exposed work force population at CRBRP is estimated as follows: Multiplying the conservative annual plant worker population dose of 1000 person-rem by the risk estimators, the staff estimates that about 0.14 cancer death may occur in the total exposed population and about 0.26 genetic disorder may occur in all future generations of the same exposed population. The value of 0.14 cancer death means that the probability of 1 potential cancer death over the lifetime of the entire work force due to 1 year of CRBRP operation is about 1 chance in 7. The risk of potential genetic disorders attributable to exposure of the workforce is a risk borne by the progeny of the entire population and is thus properly considered as part of the risk to the general public.

5.7.2.6 Transportation of Radioactive Materials

The analysis of radiological impacts from normal transportation operations of the CRBRP fuel cycle is detailed in Appendix D of this statement. The staff assessment is based primarily on the applicants' projections and assessments of impacts of transportation from the CRBRP fuel cycle as contained in Amendment XIV to the applicants' ER. In addition, the transportation of fresh mixed oxide fuel to a reactor, of spent fuel from the reactor to a fuel reprocessing plant,

and of radioactive wastes from the reactor to a burial ground is discussed generically for liquid metal fast breeder reactors in ERDA's summary report, "Environmental Impact of Transportation of Nuclear Materials in the LMFBR Program" (ERDA, 1975). Most of the information in that report is applicable to the transportation requirements of the CRBRP, although there would likely be reductions in environmental impact because of the much smaller rating of the CRBRP compared with the reference LMFBR Plant (350 MWe versus 1000 MWe). Additional information on the transportation of nuclear materials was obtained from "Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes" (NUREG-0170). An analysis of potential transportation accident impacts is presented in Section 7.2.

As shown in Table D.16 of Appendix D, the overall radiation dose to transport workers and the general population from normal transportation activities is conservatively (high-side) estimated to be 30 person-rem annually. This value represents a maximum projected annual exposure over the 30-year assumed life of the plant. To provide some perspective on this number, the cumulative dose to the workers and the population along the route from naturally radioactive sources would be about 75,000 person-rem per year. On basis of the above information and the staff's independent evaluation, the staff has concluded that the environmental risk from transportation of fresh fuel materials, irradiated fuel, and waste materials related to the CRBRP fuel cycle operations is small. Moreover, the dose to the exposed population is less than 0.1% the natural background dose and is within the range of normal variations of natural background dose at a given location.

5.7.2.7 Fuel Cycle Impacts

The CRBRP fuel cycle activities that have the potential to result in radiological impacts are: blanket fuel fabrication, core fuel fabrication, fuel reprocessing, waste management from all facilities including the CRBRP, and transportation of radiological materials to and from the reactor and fuel cycle facilities.

The fuel cycle shown in Figure A5.1 was based on the applicants' ER and was the basis for the staff's environmental analysis. A number of the facilities that would be involved in this fuel cycle are not specifically established at this time. (The commercial blanket fuel fabrication plant has not yet been selected; the fuel reprocessing plant operation may be handled in several alternative ways; and the sites for low level, transuranic (TRU), and high level waste storage and disposal are not yet established.) Accordingly, many aspects of the staff assessment have been based upon generic or model facility concepts and generic site conditions.

In that fuel cycle, depleted uranium hexafluoride from tails stockpiles at DOE's gaseous diffusion plants would be converted to uranium dioxide at a commercial fuel fabrication facility. Blanket fuel assemblies would be manufactured at the same facility, as well as depleted uranium dioxide fuel materials for the core fuel assemblies. For the assessment, the staff has used both generic data on such facilities and information from experience with operating plants.

The uranium dioxide materials for core fuel rod and axial blankets would be shipped to the Fuels and Materials Examination Facility (FMEF) at the Hanford reservation. At the FMEF the uranium dioxide powder and plutonium dioxide

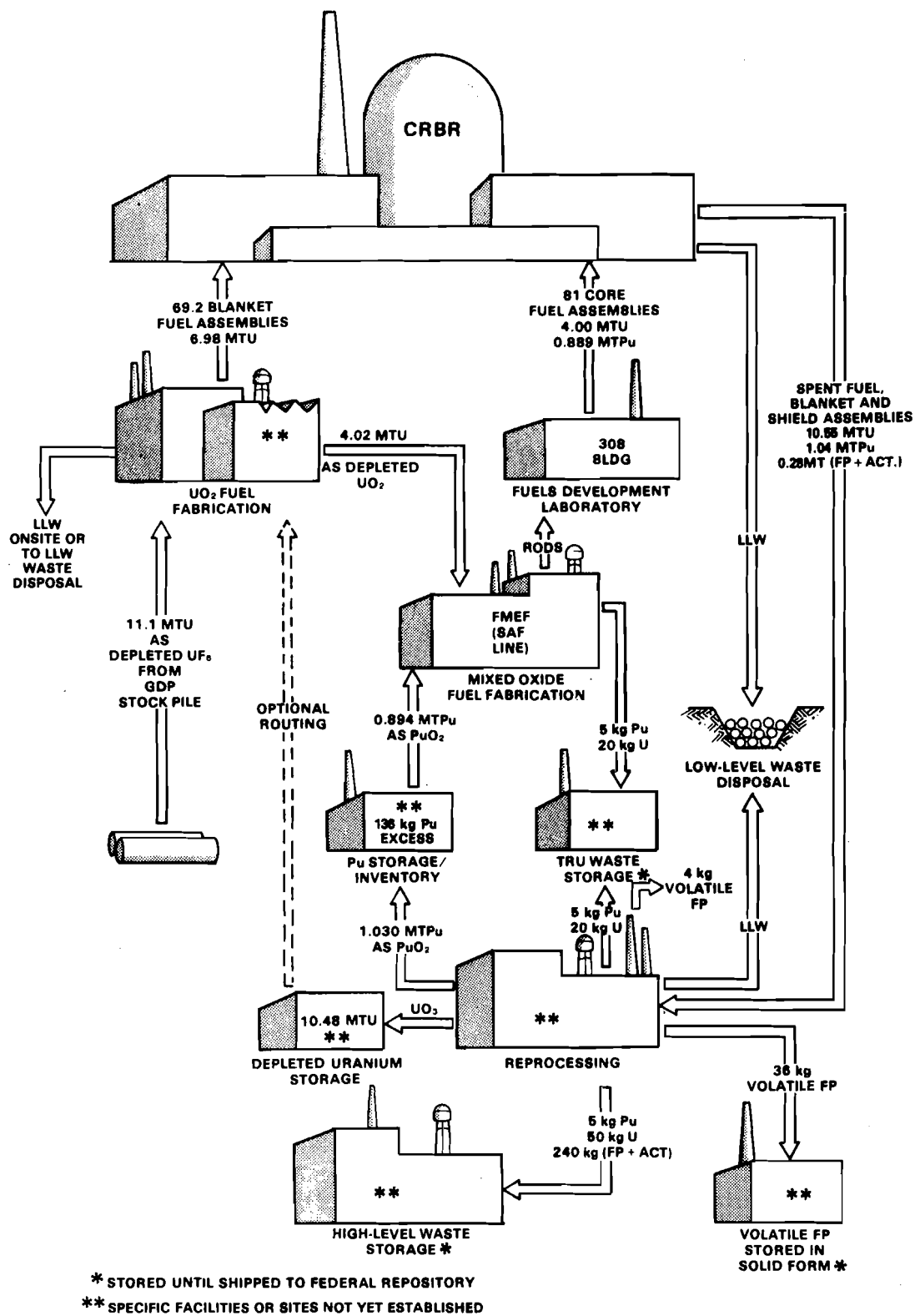


Figure A5.1 Average annual requirements for CRBRP fuel cycle

powder would be mixed and fabricated into sintered pellets for the core fuel rods in the Secure Automated Fabrication (SAF) Line. Core fuel rods containing the mixed oxide pellets in the center segment of the rod and depleted uranium dioxide pellets in the end segments of the rod (as axial blanket) would be the product of the SAF Line. The rod would be welded shut and sealed, cleaned and inspected, and transported to the nearby Fuels Development Laboratory (308 Building) where the core fuel would be fabricated into assemblies. No radioactive release would occur during operations in the 308 Building. The staff assessment of these operations is based upon DOE data for these facilities.

The completed core fuel assemblies, as well as blanket fuel assemblies, would be shipped to the CRBRP for use. After irradiation, and storage on site for a minimum of about 100 days, the irradiated (spent) fuel assemblies would be transported to a reprocessing plant where the plutonium would be separated from the uranium and fission products and other transmuted actinides. The plutonium required for new fuel under equilibrium conditions would be shipped to the FMEF for recycle. Plutonium in excess of that consumed would be stored for future use.

The staff based its assessment of the reprocessing step on the Developmental Reprocessing Plant (DRP) proposed by DOE and described in Amendment XIV of the ER. The staff believes, consistent with DOE views, that this facility, represented by design concepts, provides bounding conditions for environmental effluents that can be met by any of several alternatives for fuel reprocessing that might be chosen.

Radioactive wastes would be produced at the CRBRP and in each of the fuel cycle steps. Low level waste (LLW) produced at the uranium hexafluoride and uranium dioxide conversion and blanket fuel fabrication facility would be disposed of on site or at commercial burial grounds. Transuranic (TRU) waste would result from operations at both the core fabrication facility and at the reprocessing facility. These would be placed in temporary retrievable storage (on the Hanford reservation, for example) prior to eventual disposal in a Federal geologic repository. High level waste (HLW), after solidification at the reprocessing plant, would also be temporarily stored until it could be disposed of in a Federal geologic repository. LLW from reprocessing and from the CRBRP would be disposed of in a licensed, commercial burial ground. The staff assessment of these waste management activities is based upon generic consideration of such activities since specific sites are not available for evaluation.

Table D.4 of Appendix D summarizes the environmental considerations (resource requirements and the radioactive and nonradioactive effluents) associated with each of the fuel cycle steps, as well as the total fuel cycle.

The radiological impacts of all of these fuel cycle operations have been evaluated by the staff, and the results of these evaluations are presented in Table D.17 of Appendix D. Based on that summary of the staff assessment, the annual U.S. population whole-body dose from normal operations of the fuel cycle is projected to be approximately 170 person-rems, including the contribution from transportation discussed in Section 5.7.2.6. This estimate is higher than the values in the FES (33 person-rems from transportation and the fuel cycle) due primarily to the assumption in this assessment that higher levels of radiological gases would be released from the reprocessing step. However, both

assessment findings are very small fractions of the annual whole-body dose to the U.S. population from naturally occurring radioactive sources (approximately 28,000,000 person-rems). The potential radiological consequences of the above CRBRP fuel cycle exposures are discussed in Section 5.7.3.

5.7.2.8 Summary of Population Annual Doses

Population dose estimates are based on a projected 2010 population of 910,000 persons living within 50 miles of the plant and 29,000 receiving drinking water from Clinch River and its tributaries. At the drinking water intakes the discharge would be fully diluted by a factor of 67 over the unmixed plant discharge.

The staff assumed that 1.8×10^5 kg of fish would be caught downstream of the plant, where the discharge would be fully diluted by a factor of 67 for about one-fifth of the catch and by about 6100 for the remainder of the catch over the unmixed plant discharge. The staff assumed that the entire fish catch would be consumed by the population within the 50-mile radius.

The cumulative dose (person-rems) received from recreation by the total population was estimated by assuming that 25% of the 50-mile population would engage in 8 hr/yr each of shoreline activities, boating, and swimming (50 hr/yr for teens, 9 hr/yr for children) in the river where full dilution had taken place.

The cumulative dose (person-rems) received by the 50-mile population from ingestion of milk and beef was estimated by assuming that 1% of the milk and beef cattle would drink their water from the river where full dilution (that is, by a factor of 67) had taken place.

The staff also assumed that all of the milk and beef produced from those cattle would be consumed by the 50-mile population.

The U.S. population dose associated with the export of food crops produced within the 50-mile region and atmospheric and hydrospheric transport of the more mobile effluent species such as noble gases and tritium have been considered. Beyond 50 miles, and until the gaseous effluent reaches the north-eastern corner of the U.S., it is assumed that all the noble gases and tritium are dispersed uniformly. Decay in transit was also considered. Beyond this point, noble gases having a half-life greater than 1 year (such as Kr-85) were assumed to completely mix in the world troposphere. Tritium was assumed to mix uniformly in the world hydrosphere.

Beyond 50 miles, it was assumed that all the liquid effluent nuclides from CRBRP except tritium have deposited on the sediments so they make no further contribution to population exposures. The tritium was assumed to mix uniformly in the world hydrosphere.

Beyond 50 miles, the only liquid pathway which could add a potentially significant amount of population dose to U.S. population is the drinking water pathway. It was assumed that 1% of the U.S. population receives drinking water from the Tennessee and Mississippi Rivers downstream of the Clinch River.

The estimated doses to the 50-mile population and the U.S. population from all sources, including natural background, gaseous effluents, consumption of fish,

Table A5.5 Summary of annual whole body doses to the general public in the year 2010*

Category	Population dose (person-rem/yr)	
	Population within 50 miles	U.S. population
Natural environmental radioactivity	9.1×10^4	2.8×10^7 **
Nuclear plant operation		
Gaseous effluents	0.03	0.05
Liquid effluents	<0.01	
Fish ingestion	<0.01	<0.01
Recreation (fishing, swimming, boating)	<0.01	<0.01
Water ingestion	0.02	0.02
Beef ingestion	<0.01	<0.01
Milk ingestion	<0.01	<0.01
Transportation and supporting fuel cycle facilities	-	170

*A conservative occupational radiation exposure of 1000 person-rem is used for this impact statement (see Section 5.7.2.5).

**Based upon year 2010 projected population from "Population Estimates and Projections," Series II, U.S. Department of Commerce, Bureau of the Census, Series P-25, No. 541 (Feb. 1975).

recreation, and transportation, are presented in Table A5.5, which replaces FES Table 5.13. Although some of the dose estimates in the new table are larger than previously shown, the doses associated with nuclear plant operation are not significant compared with the dose to the population from exposure to natural background radiation. Also shown in the table for completeness of information is the annual population dose expected from the CRBRP supporting fuel-cycle facilities. Occupational radiation exposure is discussed in Section 5.7.2.5.

5.7.3 Evaluation of Radiological Impact to the General Public

The average annual dose to the total body of an individual living, playing, and working at the site boundary and eating fish, beef, and milk exposed to plant effluents now is estimated to be less than 1 mrem/yr. This value, which is less than 2% of the natural background exposure of 0.1 rem/yr (Oakley, 1972), is below the normal variation in background dose. The average dose to other individuals within a 50-mile radius of the plant would be significantly less than 1 mrem/yr.

Using conservative assumptions, a total dose of about 0.1 person-rem/yr would be received by the estimated 2010 population of 910,000 living in unrestricted areas within a 50-mile radius of the plant. By comparison, an annual total of about 9.1×10^4 person-rem is delivered to the same population as a result of the average natural background dose rate of about 0.1 rem/yr.

The radiological doses and dose commitments resulting from nuclear power plants are well known and documented. Accurate measurements of radiation and radioactive contaminants can be made with very high sensitivity so that much smaller amounts of radioisotopes can be recorded than can be associated with any possible observable ill effects. Furthermore, the effects of radiation on living systems have for decades been subject to intensive investigation and consideration by individual scientists as well as by select committees, occasionally constituted to objectively and independently assess radiation dose effects. Although, as in the case of chemical contaminants, there is debate about the exact extent of the effects of very low levels of radiation that result from nuclear power plant effluents, upper bound limits of deleterious effects are well established and amenable to standard methods of risk analysis. Thus the risks to the maximally exposed member of the public outside of the site boundaries or to the total population outside of the boundaries can be readily calculated and recorded. These risk estimates for CRBRP are presented below.

The risk to the maximally exposed individual is estimated by multiplying the risk estimators presented in Section 5.7.2.5 by the estimated annual total body doses to the maximally exposed individual. This calculation results in a risk of potential premature death from cancer to that individual from exposure to radioactive effluents from 1 year of reactor operations of less than 1 chance in 1 million. The risk of potential premature death from cancer to the average individual within 50 miles of the reactor from exposure to radioactive effluents from the reactor is much less than the risk to the maximally exposed individual. These risks are very small in comparison to natural cancer incidence from causes unrelated to the operation of CRBRP. Multiplying the annual U.S. population dose from exposure to radioactivity attributable to the normal operation of CRBRP and its related fuel cycle (i.e., 170 person-rem to the general public) by the preceding somatic risk estimator, the staff estimates that about 0.023 potential cancer death may occur in the exposed population. For purposes of evaluating the potential genetic risks, the progeny of workers at CRBRP are considered members of the general public. Multiplying the sum of the U.S. population dose to the general public from exposure to radioactivity attributable to the normal annual operation of CRBRP and its related fuel cycle (i.e., 170 person-rem), and a conservative estimate of the dose from occupational exposure (i.e., 1000 person-rem) by the preceding genetic risk estimators, the staff estimates that about 0.30 potential genetic disorder may occur in all future generations of the exposed population. The significance of these risk estimates can be determined by comparing them to the natural incidence of cancer death and genetic abnormalities in the U.S. population and in the first five generations of the U.S. population, respectively. Multiplying the estimated U.S. population for the year 2010 (~280 million persons) by the current incidence of actual cancer fatalities (~16%) and the current incidence of actual genetic ill health (~11%), about 45 million cancer deaths and about 150 million genetic abnormalities in the U.S. population and in the first five generations respectively are expected (HHS 1981, BEIR III). The risks to the general public from exposure to radioactivity attributable to the annual operation of CRBRP are very

small fractions (less than 10 parts in a billion) of the estimated normal incidence of cancer fatalities and genetic abnormalities in the year 2010 population and in the first five generations of the year 2010 population, respectively.

On the basis of the preceding comparison, the staff concludes that the potential risk to the public health and safety from exposure to radioactivity attributable to normal operation of CRBRP and its related fuel cycle will be very small.

5.8 Conclusion

Although various minor changes are noted in this chapter relative to environmental parameters and effects of plant operation and some new information is presented, there are no significant changes in the impacts to the environment from those assessed in the FES.

6 ENVIRONMENTAL MEASUREMENT AND MONITORING PROGRAMS

6.1 Preoperational

6.1.1 Hydrological

No changes have been made to this section of the FES.

6.1.2 Radiological

The applicants have modified their proposed offsite preoperational radiological monitoring program identifying background levels of radiation and radioactivity in the plant environs. The program would permit the applicants to train personnel and evaluate procedures, equipment and techniques, as indicated in Regulatory Guide 4.1. The applicants' modified program, to be started 2 years before plant operation, is summarized in Table A6.1, which replaces FES Table 6.1. Vertical lines in the right-hand column of the table indicate where changes were made. Sampling locations are shown in Figures A6.1 and A6.2, which supersede similar figures in the FES. More detailed information is in ER Section 6.2. The number of thermoluminescent dosimeter (TLD) locations will have to be updated to conform to the criteria in the Radiological Assessment Branch Technical Position, Revision 1, November 1979, "An Acceptable Radiological Environmental Monitoring Program." However, provided the number of TLD locations is thus updated, the staff considers the proposed program adequate.

6.1.3 Meteorological

From April 1973 to March 1978, a temporary 200-ft instrumented tower was in operation southwest of the proposed reactor site. In February 1977, two permanent instrumented towers were installed: a 10-m tower north of the site and a 110-m tower southeast of the site. Simultaneous measurements were taken on the temporary and permanent towers during the period February 16, 1977 to March 2, 1978. After that time, no measurements were taken. On April 1, 1982 operation of the permanent tower was resumed. The data acquisition equipment is located in a trailer at the base of the 110-m tower with data from the 10-m tower being telemetered to this same location. The 10-m tower instrumentation consists of wind speed and wind direction sensors located at the 10-m level. The 110-m tower instrumentation consists of wind speed and direction sensors located at the 10-, 60-, and 110-m levels; temperature sensors at the 10-, 60-, and 110-m levels; dew point sensors at the 10-m level; and solar radiation and precipitation sensors at the 1-m level.

The permanent measurement system consists of the following sensors (ER pp. 6.1-32a, 32b, and 32c):

Wind Sensors - Climet Model 011-1 wind speed sensor and Climet Model 012-10 wind direction sensor. The operating range of the wind speed sensor is 0.6 to 110 mph, with an accuracy of 1% of true value or 0.15 mph, whichever is greater. The direction sensor operates through a range of 0-540° with an accuracy of $\pm 3^\circ$.

Table A6.1 Radiological environmental monitoring program

Sample type	Number of samples and locations	Sampling and collection frequency	Type and frequency of analysis
Airborne particulates	4 samples offsite in sectors of highest wind frequency	Continuous sampler operation with weekly sample collection	Weekly-gross beta, gross alpha
	9 samples within 10 miles in sectors of highest wind frequency		Monthly composite-gamma scan, Pu, Sr, and U quarterly
	2 control samples		
Airborne radioiodine	Same as airborne particulate locations	Same as airborne particulates	I-131
Heavy particulate fallout	Same as airborne particulate locations	Continuous sampler operation	Monthly composite--gross beta, gross alpha
Rainwater	Same as airborne particulate locations	Continuous sampler operation	Monthly composite gross beta, gamma scan, Sr-89, 90, H-3
Airborne moisture	4 samples at local airborne particulate locations	Continuous sampler operation with weekly sample collection	Biweekly composite-H-3
	1 control sample		
Soil	Same as airborne particulate locations	Annually	Gross beta Gross alpha Gamma scan Pu U
Direct radiation	Near plant boundaries and at airborne particulate locations	Quarterly	Thermoluminescent dosimeters

Table A6.1 (Continued)

Sample type	Number of samples and locations	Sampling and collection frequency	Type and frequency of analysis
Vegetation (grass, weeds, and so forth)	Same as airborne particulate	Quarterly	Gross beta Heavy metal total alpha Gamma scan Sr-89, 90 Pu
Pasturage grass	Nearby dairy farms	Quarterly	Same as vegetation analyses
Beef		Based on trigger levels in pasture grass	
Milk	Nearby milk animals	Monthly	Gamma scan Sr-89, 90 I-131
		Biweekly during pasture months	I-131
Groundwater	Nearby wells	Monthly	Gross beta, gross alpha, and gamma scan monthly Pu quarterly
Food crops	Nearby farms	Annually	Gross beta Heavy metal total alpha gamma scan Sr-89, 90 Pu
Surface water	All potable water intakes within 10 miles upstream and downstream	Automatic sequential sampling, collected monthly	Gross beta, gross alpha, and gamma scan H-3, Pu quarterly
	Samples at Clinch River River miles 14.4, 15.4, 18.6, 24.0	Same as above	Gross beta, gross alpha Gamma scan H-3 Sr-89, 90 Pu and U (one downstream sample and one upstream)

Table A6.1 (Continued)

Sample type	Number of samples and locations	Sampling and collection frequency	Type and frequency of analysis
Fish	Upstream and downstream of Melton Hill Dam	Semi-annually	Recreational-gross beta Gross alpha Gamma scan Commercial same as recreational plus Sr-89, 90, and Pu
Sediment	4 to 6 locations	Semi-annually	Same as commercial fish analysis
Asiatic clams	4 to 6 locations	Semi-annually	Shell-Sr-89, 90, Pu Edible portion-gross beta gross alpha gross scan

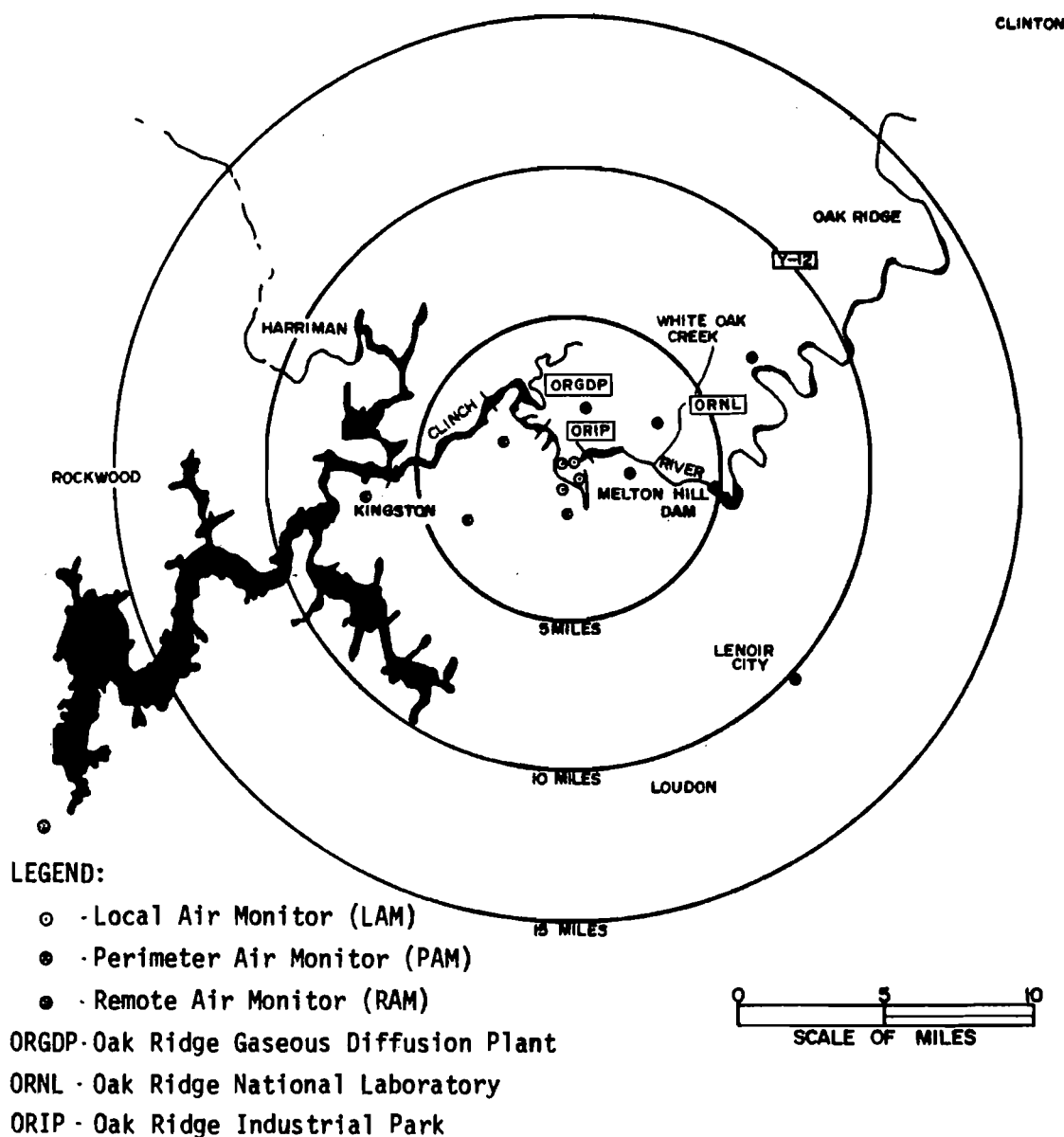
Dry Bulb Temperature - Aspirated Aerodet Model R-22.3-E100 platinum resistance temperature sensor is currently located at the 10-, 60-, and 110-m tower levels. The sensor range is -9.9°F to 99.9°F , with an accuracy of $\pm 0.06^{\circ}\text{F}$.

Temperature Difference - Between the tower levels of 10-, 60-, and 110-m, Δ temperature values are determined from the separate dry bulb temperature sensors. In view of radiation and recording device errors common to both temperature sensors, the Δ temperature system has a maximum error of $\pm 0.14^{\circ}\text{F}$.

Dew Point - An EG&G Model 110s(M) dew point hygrometer records dew point temperatures in the range of 0° to 100°F . The accuracy of this sensor is $\pm 0.5^{\circ}\text{F}$.

Rainfall - Bellfort Instrument Co. Model 5915-12 spring weighing and potentiometer output type records in the range 0-9.99 in. with an accuracy of ± 0.06 in.

Solar Radiation - Eppley Laboratories Model 8-48, 180 Pyranometer.



NOTE: The following samples are collected at each monitoring site:

Air Particulates	Rainwater
Radiiodine	Soil
Heavy Particles	Vegetation
Fallout	

Figure A6.1 Atmospheric and terrestrial radiological monitoring network for CRBRP

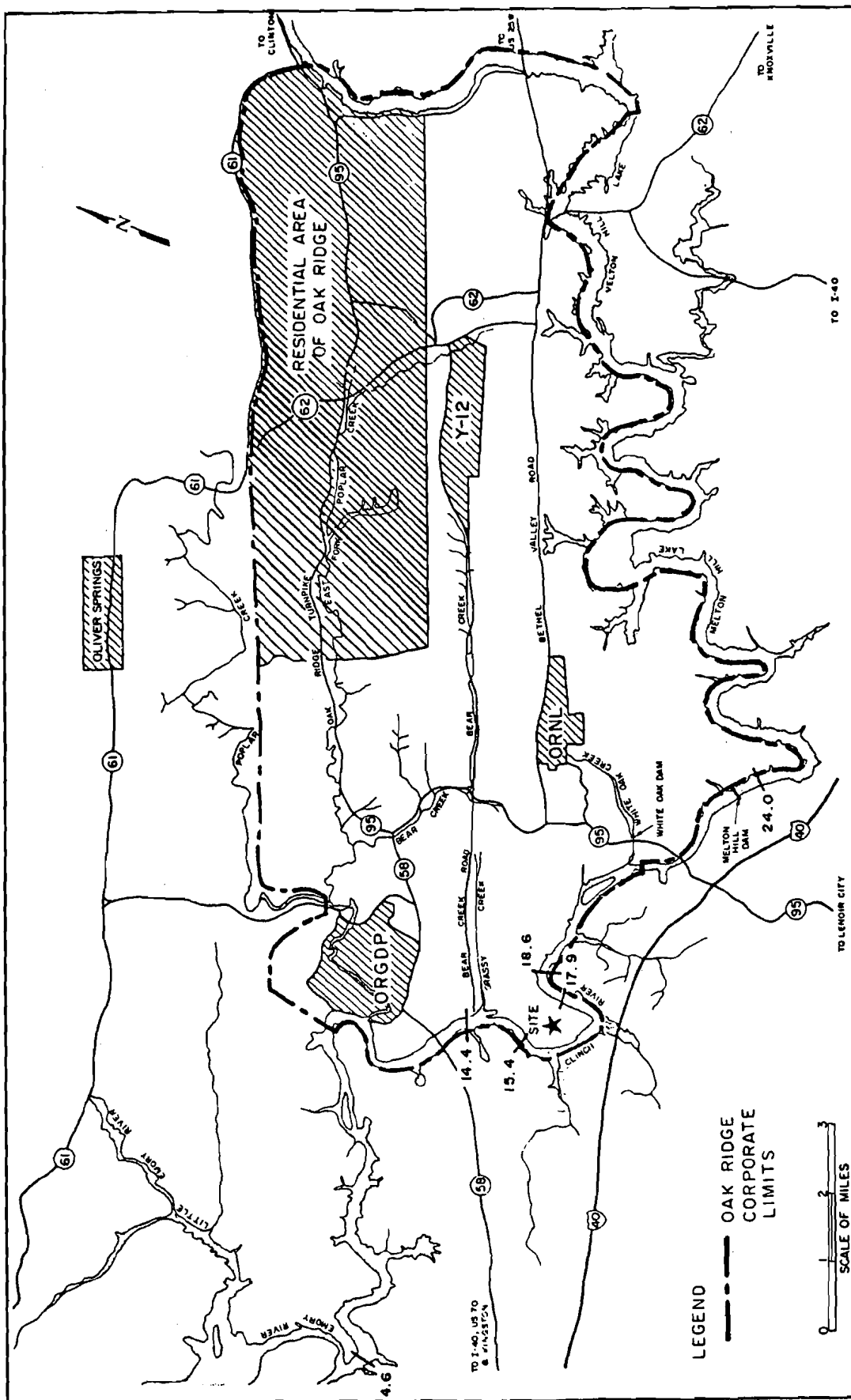


Figure A6.2 Reservoir radiological monitoring network for CRBRP (ER Fig. 6.2-2)

Data from this system are recorded by a digital system interfaced with a NOVA 1200M Minicomputer and peripheral equipment. Wind direction and speed values are also recorded by an analog system. A calibration program for the sensors has been in effect, along with an adequate data reliability program, during both the previous and the present operation.

The onsite program, in terms of sensor accuracy, calibration intervals, and recovery rate, meets the standards required in Regulatory Guide 1.23.

To provide relative concentrations (χ/Q) and deposition (D/Q) values for use in making radiological dose assessments (Section 5.7), the staff used the joint frequency distributions of wind speeds and direction by atmospheric stability class collected on site from the 110-m permanent tower for the period February 17, 1977 through February 16, 1978. Wind speed and direction were measured at the 10-m level, while atmospheric stability was derived from the vertical difference in temperatures between the 10-m and 60-m levels. The joint data recovery rate of 10-m wind speed and wind direction, and the temperature difference between the 10-m and 60-m levels, was 97%.

In evaluating these atmospheric transport and diffusion characteristics, the staff used a "Straight-Line Trajectory Model," as described in Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors." Continuous releases only were evaluated and all releases were assumed to be at ground level. The calculations also included an estimate of the maximum increases in calculated relative concentration and deposition due to recirculation and stagnation of airflow not considered in the straight-line trajectory model.

6.1.4 Ecological

6.1.4.1 Aquatic

In accordance with Section 511(c)(2) of the Clean Water Act, EPA now has the lead role in establishing nonradiological aquatic monitoring requirements.

The baseline aquatic monitoring program was conducted between March 1974 and May 1975. The purpose of this program was to identify the important ecological characteristics of the CRBRP site. Sampling transects and locations according to biotic category are shown in FES Figure 6.3; that figure is reproduced here with several minor additions as Figure A6.3. The sampling schedule was given in FES Table 6.2 (ER Table 6.1-1) and the methods and frequencies in FES Table 6.3 (ER Table 6.1-2); however, those tables in the ER were amended in 1981, as shown in Tables A6.2 and A6.3.

The preconstruction monitoring program was initiated in March 1975 and discontinued in January 1978. The initial preconstruction monitoring was conducted monthly during the period from March 1975 through October 1975 and included monitoring water quality, phytoplankton, periphyton, zooplankton, and benthic macroinvertebrates at four transects in the Clinch River. The monitoring program was revised in January 1976, and a reduced monitoring program with varying sampling frequency was conducted from January 1976 through January 1978, monitoring water quality and benthic macroinvertebrates at four transects in the Clinch River. FES Table 6.4 summarized this program; however, that table

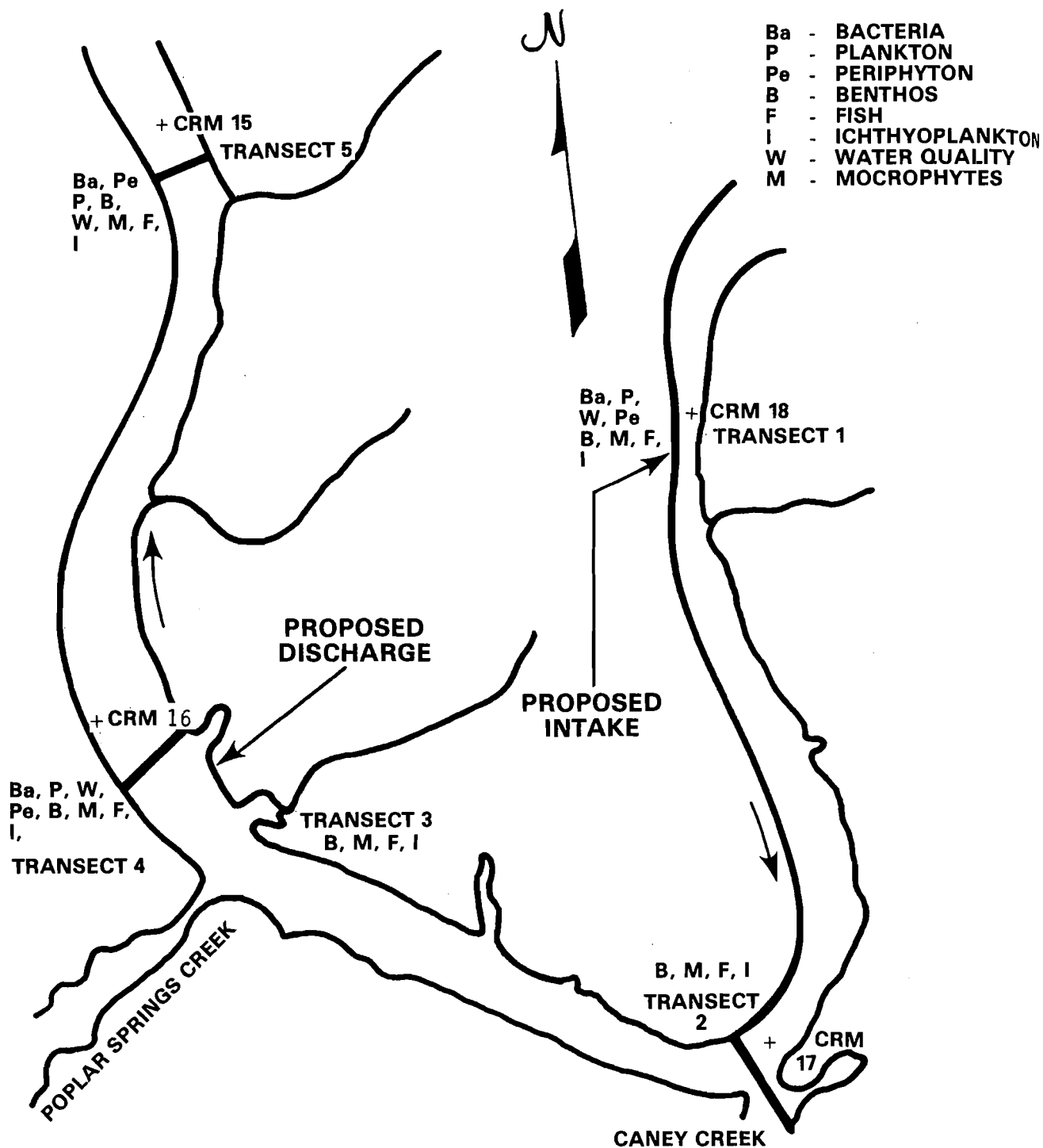


Figure A6.3 River sampling transects for the baseline aquatic monitoring program (replaces FES Fig. 6.3)

Table A6.2 Aquatic sampling schedule

	1974										1975				
	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M
Biological parameters															
Bacteria	X		X	X	X	X	X		X		X			X	
Phytoplankton	X		X	X	X	X	X		X		X			X	
Zooplankton (tows)	X		X	X	X	X	X		X		X			X	
Zooplankton (pumping)	X		X	X	X*										
Periphyton	X		X	X		X		X			X				X
Benthos (dredging)	X		X	X	X	X	X		X		X			X	
Benthos (artificial substrate)	X**		X**	X**	X	X	X		X		X				X
Macrophytes	X		X		X										
Fish populations	X		X	X	X	X	X		X		X			X	
Fish eggs and larvae	X+	X+	X+	X+	X+	X+					X				
Fish stomach contents	X		X	X		X	X		X		X				
Physical and chemical parameters															
Field measurements	X		X	X	X	X	X		X		X			X	
Routine lab analyses	X		X	X	X	X	X		X		X			X	
Additional analyses	X						X								
Sediment analyses															
Particle size and organic content	X		X		X		X				X			X	
Heavy metal content	X													X	
Total phosphate content	X													X	
Trace elements														X	
Polychlorinated biphenyls (PCBs)														X	
Insecticides														X	

*Pump sampling was discontinued after this trip.

Source: ER Table 6.1-1

**Most samplers were damaged in river.

+Once every 2 weeks.

Table A6.3 Aquatic sampling methods and frequencies

Parameter	Sampling/Frequency	Sampling Method	Analyses	Sampling location
BIOLOGICAL				
<u>Bacteria</u>				
Standard plate count	Once each month in March, May-Sept, and Nov. (1974); and Jan and April (1975)	surface collection (1 ft below surface) using sterilized glass containers	(1) concentration expressed as colonies/100 ml	Figure 6.3
Total coliform count			(2) analyses according to "Standard Methods"*	
Fecal coliform count				
Fecal strep count				
<u>Phytoplankton</u>	Once each month during March, May-Sept, and Nov (1975); and Jan and April (1975)	(1) Van Dorn bottle (2) surface collection	(1) identification to the specific level, when practical (2) number/liter (3) species diversity (4) percent composition--major groups (5) biomass (chlorophyll <u>a</u> method including measurement of chlorophyll <u>b</u> , <u>c</u> , and pheophytin <u>a</u> content ratio)	Figure 6.3
<u>Zooplankton tows</u>	Once each month during March, May-Sept, and Nov (1974); and Jan and April (1975)	(1) vertical tows (2) 0.5 m diameter 0.76 μ mesh plankton net with TSK outside and inside flow meters (3) horizontal surface tows beginning in September	(1) identification to the specific level, when practical (2) number/liter (3) species diversity (4) composite biomass (volume by displacement or measurement of cells depending on abundance)	Figure 6.3
<u>Zooplankton pumping</u>	Once each month during March, May, June, and July (1974)	(1) submersible pump (2) filtered through a 0.76 μ mesh plankton net (3) surface, mid, and bottom collections	(1) identification to the specific level, which practical (2) number/liter (3) species diversity (4) composite biomass (volume by displacement or measurement of cells depending on abundance)	Figure 6.3
<u>Periphyton</u>	Once each month during May, June, Aug, and Oct (1974); and Jan	(1) plexiglass slides on floating racks (2) 2-4 week exposure period	(1) identification to the specific level, when practical of species of all groups of algae (2) species diversity (3) autotrophic index	Figure 6.3
<u>Benthos dredging</u>	Once each month during March, May-Sept, and Nov (1974); and Jan and April (1975)	Ponar dredge	(1) identification to the specific level, when practical (2) number/m ² and number/liter (3) size ranges of larger mollusks (4) species diversity (5) composite biomass (blotted wet weight and ash-free dry weight)	Figure 6.3

Table A6.3 (Continued)

Parameter	Sampling/Frequency	Sampling Method	Analyses	Sampling location
<u>Benthos artificial substrate</u>	Once each month during March, May-Sept, and Nov (1974); and Jan and May (1975)	(1) hardboard, multi-plate sampler suspended 1 to 2 ft above bottom	(1) identification to the specific level, when practical (2) number/m ² (3) species diversity (4) composite biomass (blotted wet weight and ash-free dry weight)	Figure 6.3
<u>Macrophytes</u>	Once each month during March, May and July	(1) collection by hand (2) quantitative sampling within quadrates if substantial growth encountered	(1) identification to the specific level, when practical (2) composite biomass (blotted wet weight and ash-free dry weight) (3) construction of vegetation map if substantial growth encountered	Figure 6.3
<u>Fish</u>	Once each month during March, May-Sept, and Nov (1974); and Jan and April (1975)	(1) electoshocking (2) gill nets (3) scale collection of most abundant species	(1) species composition (2) relative species abundance (3) percentage game, rough, and forage fish (4) species diversity (5) length and weight determinations (6) condition factor of 7 most abundant species (7) length by age-growth curves of 7 most abundant species	Figure 6.3
<u>Fish eggs and larvae</u>	Once every 2 weeks during March through August	(1) stationary bottom 1,000µ ichthyoplankton net with TSK inside and outside flow meters (2) pumping using submersible pump 1 to 2 ft from bottom	(1) density (number/m ³) (2) stage of development (3) species identification, when practical	Figure 6.3
<u>Fish stomach contents</u>	Once each month during March, May, June, Aug, Sept, and Nov (1974) and Jan (1975)	collection of stomachs from each of the 7 most abundant fish species	(1) identification of food items to the most specific taxon practical (2) number and percent abundance of food items (3) percent fullness of stomach (4) net weight of stomach contents	Figure 6.3

Source: ER Table 6.1-2

Table A6.4 Preconstruction aquatic environmental monitoring program

Station Location	Horizontal Location ¹	Physical-Chemical				Biological			
		In situ ²	General ³	Comprehensive ⁴	Fecal coliforms ⁴	Primary productivity (in situ C ₁₄) ⁵	Submarine photometer ⁵	Benthos (artificial Substrates) ⁶	Benthos (dredge) ⁷
CRM 19.0	50								X
	95							X	
CRM 17.9	50	0.3,1,1.5,3, 5,6	1,3,5	1,3,5	0.1	0.1,1,3,5	0.1,1,3,5		X
	5	(0.3,1,1.5,3) ⁸				0.1,1,3	0.1,1,3		
	95	(0.3,1,1.5,3) ⁸				0.1,1,3	0.1,1,3,5	X	
CRM 15.4	50	0.3,1,1.5,3 5,6	1,3,5			0.1,1,3,5	0.1,1,3,5		X
	5	(0.3,1,1.5,3) ⁸				0.1,1,3	0.1,1,3		
	95	(0.3,1,1.5,3) ⁸				0.1,1,3	0.1,1,3	X	
CRM 14.4	50	0.3,1,1.5,3, 5,6	1,3,5	1,3,5	0.1	0.1,1,3,5	0.1,1,3,5		X
	5	(0.3,1,1.5,3) ⁸				0.1,1,3	0.1,1,3		
	95	(0.3,1,1.5,3) ⁸				0.1,1,3	0.1,1,3	X	
Peripheral stormwater runoff									
CRM 15.5	0.4 ⁹			S ¹⁰					
CRM 15.95	0.1			S					
CRM 16.10	0.2			S					
CRM 16.50	2.4			S					
Groundwater									
Well A-58				X ¹¹					
Well E-60				X					
Well R-62				X					
Well G-68				X					
Well A-70				X					
Well N-70				X					
Well-									
auto sampled					X				

¹Percent from the left bank, facing the downstream direction.²Measurements made in situ for dissolved oxygen, pH, temperature, and conductivity once during January and monthly March through October.³Measurement made for alkalinity (field), nitrogens, phosphorus, COD, TOC, solids, turbidity, and colors once during January and monthly March through October.⁴Measurements made for BOD, fecal coliform, Cd, Ca, Cl, Cr, Cu, Fe, Pb, Mg, Mn, Hg, Ni, K, SiO₂, Na, SO₄, and Zn once during months of January, April, July, and October.⁵Primary productivity (in situ C₁₄ uptake) and submarine photometer (percent light perbiastion) measurements made once during months of March through October.⁶Artificial substrates for benthos - 2-month exposures; Placed in months of March, May, July, and September and removed in May, July, September, and November. Samples used to quantify biomass, numbers, and diversity.⁷Dredge for benthos and particle-size analysis once during months of March, May, July, and September. Samples used to quantify biomass, numbers, diversity, and substrate type.⁸Initiated in June 1977.⁹Kilometers from mouth of drainage ways all located at 100 percent from left bank, facing the downstream direction.¹⁰Samples analyzed for pH and temperature in the field, and suspended solids and turbidity in the laboratory. Sampling initiated in June 1976 on a monthly basis.¹¹Samples analyzed for pH and temperature in the field and conductivity, alkalinity, P, solids, Na, SO₄, B, Cd, Cr, Cu, Pb, Mn, Ni, and Zn in the laboratory. Sampling initiated in June 1976 on a quarterly basis.

Source: ER Table 6.1-4a

is replaced here by Table A6.4 (ER Table 6.1-4a) to provide more complete information. Detailed accounts of these programs are presented in ER Section 6.1.1.2.

An Erosion and Sediment Control Plan, dated July 16, 1982, with revisions dated July 28, 1982, has subsequently been revised and approved by EPA, Region IV and the State of Tennessee.

The staff maintains that the most effective method to minimize the impact of plant construction on aquatic organisms is to utilize sound engineering practices and to monitor pertinent water quality parameters (such as total suspended solids) at or near the source(s) of construction runoff so that potential impacts can be detected at an early stage. Then, through direct feedback of information to appropriate construction personnel, such impacts can be minimized before adverse conditions affect aquatic life in the river. The staff concludes that the protection of the aquatic environment will be adequately achieved by the Erosion and Sediment Control Plan and by the recommended scheduling of construction activities in the river. Therefore, the staff will not require the studies indicated by the applicants in the ER.

The staff recommended that, before significant site preparation and inriver activities begin, the applicants conduct a one-time survey of the Clinch River for species of threatened or endangered freshwater mussels. This survey was completed during May 1982, and the results are discussed in Section 5.3.4.

The NPDES Permit (Part III.M) also requires, prior to the start of construction of the plant discharge structure, that studies be made to ensure that thermal discharges will have minimal impact on striped bass.

The preconstruction monitoring program is separate from the preoperational monitoring program. In accordance with the NPDES Permit (Part III.N), the latter will be designed and implemented 2 years before the scheduled fuel loading and will be based on details of the final plant design and environmental data available at that time.

6.1.4.2 Terrestrial

No changes have been made to this section of the FES.

6.1.5 Chemical and Physical

During the baseline program (March 1974 through May 1975), water quality sampling was done at three transects in the river (Figure A6.3) and the measurements were scheduled as shown in FES Table A6.2. The parameters measured were identified in FES Table 6.6, which is replaced here by Table A6.5 (ER Table 6.1-2) to provide more complete information.

In March 1975, TVA began the preconstruction-construction effects monitoring program, which was based primarily on a continuation of many features of the baseline program. This program was reviewed and revised in January 1976 to reflect a more comprehensive site-specific construction effects monitoring program. The program was discontinued in 1978 at the request of ERDA. Under the revised program, TVA collected physical/chemical data by sampling at CRM 23.1, CRM 19.0, and CRM 17.9, upstream from the site, and CRM 15.4 and

Table A6.5 Sampling methods for physical and chemical parameters--aquatic baseline survey

Parameter	Sampling/Frequency	Sampling Method	Analyses
PHYSICAL AND CHEMICAL			
A. Field measurements	Once each month in March, May-Sept, and Nov (1974) and Jan and April (1975)	(1) Temperature, pH, DO, and conductivity measured by Hydrolab unit and additional electronic recording units (2) Light penetration measured by submarine photometer (3) Velocity measured by Gurley and Savonium meters; current direction by internal compass (4) Water depth measured by recording fathometer	(1) Temp in °C (2) pH in pH units (3) Dissolved oxygen in mg/l (4) Conductivity in μmho (5) Light penetration in foot-candles and % transmittance; determination of 1% light incidence (6) Water depth in meters (7) Water velocity in feet per second (fps)
Temperature (profile) Dissolved oxygen (profile) Water velocity and current direction (profile) pH (surface, mid, bottom) Specific conductivity (surface, mid, bottom) Light penetration (profile) Water depth			
B. Routine Laboratory Analyses	Once each month in March, May-Sept, and Nov 1974 and Jan and April (1975)	"Standard Methods"	(1) Concentration expressed in parts per million (2) Turbidity in Jackson turbidity units (3) Color in color units (4) "Standard Methods" used in all analyses except for sodium and potassium in which case "Methods for Chemical Analysis" is used
Total alkalinity (CaCO_3) Hardness (CaCO_3) Turbidity Color (true) BOD COD TOC (total organic carbon) Chloride Chlorine residual (field method) Sulfate Sodium Potassium Solids Dissolved Settleables Suspended Volatile Fixed (by difference) Total Volatile Fixed (by difference) Nitrogen NO_2 NO_3 NH_3 Phosphate Total - PO_4 Ortho - PO_4			

Table A6.5 (Continued)

Parameter	Sampling/Frequency	Sampling Method	Analyses
C. Additional Analyses	Once during March and Sept 1974	"Standard Methods"*	Analyses were done using "Standards Methods"* except for: (a) mercury, molybdenum, and nickel in which case "Methods for Chemical Analysis"*** was used, (b) nitrogen gas in which case the Van Slyke method+ was used, and (c) selenium in which case "Proposed Tentative Method"++ was used
Chlorine demand			
Fluoride			
Nitrogen gas			
Silicate			
Calcium			
Magnesium			
Molybdenum			
Selenium			
Tin			
Aluminum			
Manganese			
Zinc			
Copper			
Mercury			
Silver			
Arsenic			
Cadmium			
Chromium			
Lead			
Nickel			
Cobalt			
Iron (total)			
Organic compounds			
Cyanide			
Detergents-surfactants (MBAS)			
Oil and grease (solvent extraction)			
Phthalate esters			
Pesticides			
Organochlorines (insecticide)			
Atrazine (herbicide)			
2-4-D (herbicide)			
SEDIMENT			
A. Particle size and total volatile (organic) solid content	Once each month during March, May, July and Sept (1974) and Jan and April (1975)	Collection by dredge	(1) Particle size determination as in "Shore Protection"▽ (2) Total volatile solid content by combustion according to "Standard Methods"*
B. Total Phosphate Content Heavy Metal Content	Once at the beginning of the study and once at the end of the study, March 1974 and April 1975	Collection by dredge	Acidification, then procedure as in "Standard Methods"* for metal analysis
Molybdenum			
Selenium			
Tin			

Table A6.5 (Continued)

Parameter	Sampling/Frequency	Sampling Method	Analyses
Aluminum			
Manganese			
Zinc			
Copper			
Mercury			
Silver			
Arsenic			
Cadmium			
Chromium			
Lead			
Nickel			
Cobalt			
Iron (total)			
C. Trace Elements	Once in April 1975	Collected by dredge	(1) Metals: acidification, then procedure as in "Standard Methods"*
Polychlorinated Biphenyls			(2) Other: "Standard Methods"* or "Methods for Chemical Analysis"***
Insecticides			
Beryllium			
Fluoride			
Magnesium			
Antimony			
Vanadium			
Bromine			
Bismuth			
Calcium			
Strontium			
Potassium			
Sodium			
Niobium			
Silica			
Titanium			
Zirconium			
Barium			
Lithium			
Scandium			
Germanium			
PCBs			
Chlordane (α and γ)			
DDE			
DDD			
DDT			

Source: ER Table 6.1-2

*Standard Methods for the Examination of Water and Waste Water, American Public Health Association, Washington, D.C., 1971.

**Methods for Chemical Analysis of Water and Wastes, EPA, Water Quality Office, Analytical Quality Control Laboratory, Cincinnati, Ohio, 1971.

+Van Slyke, Donald D., and Neil, J. H., Journal of Biological Chemistry, 61:523, 1924.

++Proposed Tentative Method of Test for Selenium in Water, American Society of Testing Materials, November 1970.

vShore Protection, Planning and Design, Technical Report No. 4, U.S. Army Corps of Engineers, 1966.

CRM 14.4, both downstream from the site (see Figure A6.4, which supersedes FES Figure 6.4) (ER Fig 6.1-11). The additional data gathered after January 1978 were considered in updating Chapters 2, 3, 4, and 5 of this document.

Requirements for monitoring during construction are specified in the NPDES Permit, Page I-3 (see Appendix H).

The staff will provide input, as appropriate, to EPA in the review of the monitoring programs proposed under the terms of the NPDES Permit.

6.1.6 Socioeconomic

The staff's analysis in Chapter 4 indicated that increased utilization of community facilities and services would occur as a result of the construction of the CRBRP but that tax revenues to local governments would probably balance such demands. To assist the affected communities to plan for changes, the staff will impose a monitoring requirement on the applicants. This monitoring effort will involve the following elements:

- (1) A survey of the primary work force as discussed in Section 6.1.6.1 below.
- (2) Traffic counts on selected roads.
- (3) Surveys of the school enrollment of children from inmoving construction and operating phase worker households.
- (4) Surveys of mobile home developments.
- (5) Surveys of the demand for other publicly supplied services as appropriate.

The procedures used to implement these surveys and their scope shall be developed so as to record impacts of significance. The applicants agree to provide the findings of the socioeconomic monitoring process to appropriate representatives of the State of Tennessee and the City of Oak Ridge and planning agencies in the project area as surveys are conducted. In addition, the applicants agree to evaluate the significance of socioeconomic effects resulting from construction of the CRBRP and to provide descriptions of the project-related effects to representatives of both the State of Tennessee and the City of Oak Ridge and appropriate planning agencies. In cases where project-related effects are significantly different from effects projected in the CRBRP FES, the applicants will provide the opportunity for meetings with appropriate state and local officials to (1) identify specific assessments necessary to determine the magnitude of impacts, and (2) arrange for corrective measures, procedure plans or program development, consistent with existing statutory authority, to minimize the severity of adverse socioeconomic impacts.

6.1.6.1 Primary Work Force Surveys

On a periodic basis the applicants shall determine certain demographic-sociological data on the primary work force. The primary work force is taken to mean direct manual, nonmanual, subcontractor, and operations employees (see

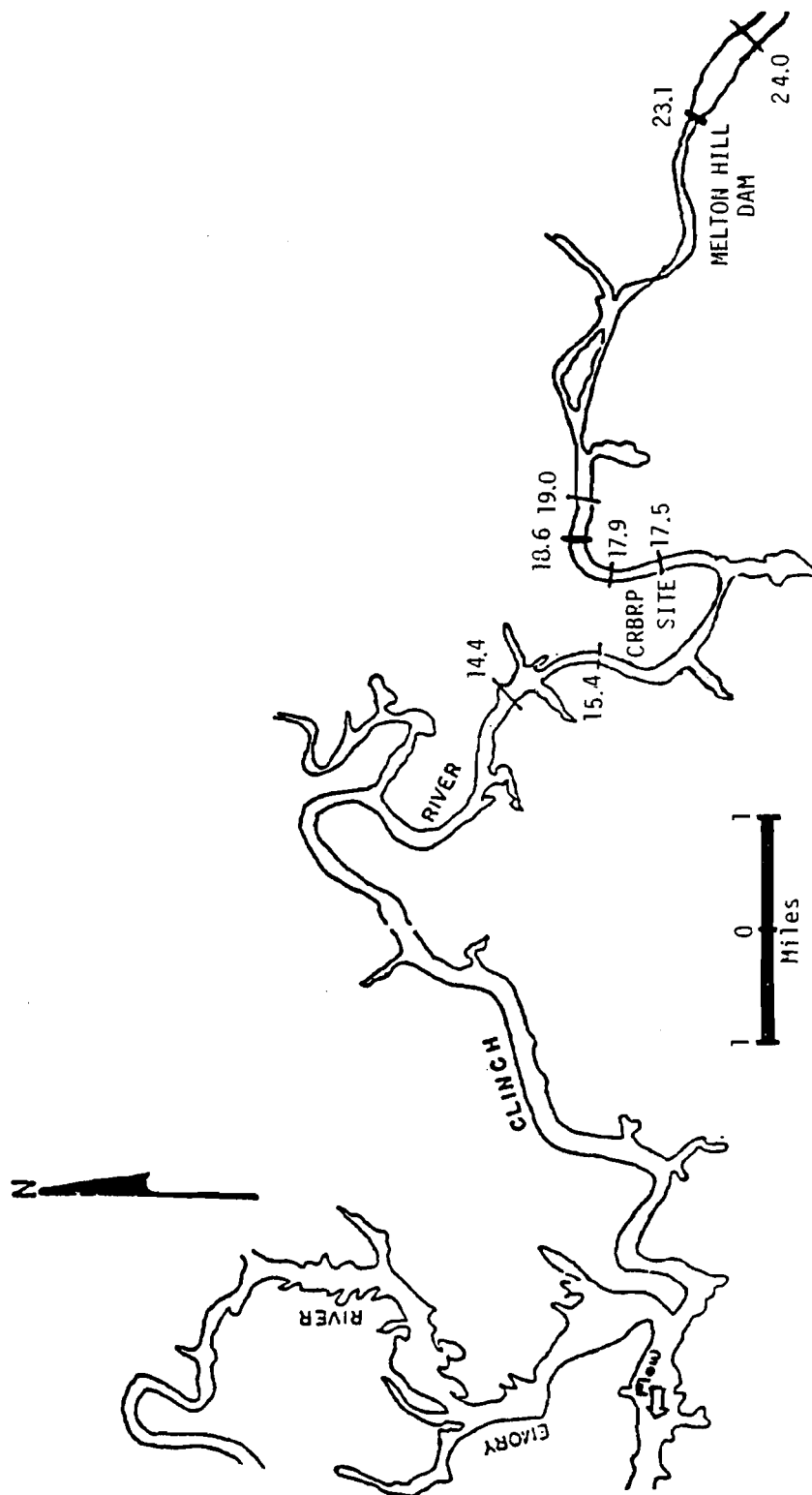


Figure A6.4 Reservoir environmental monitoring network, preconstruction-construction phase

Table A4.1). The desirable data would be family composition, place of residence, type of housing, length of time at current address, length of time at previous address, number and grades of school-age dependents, and occupation. Surveys should be undertaken when employment changes by 1000 and should not be initiated more frequently than every 6 months or more infrequently than once per year.

6.1.6.2 Reporting

The staff recommends that the reports of each survey be submitted to the NRC staff and the major authorities in the affected areas within 4 months after the initiation of each survey.

6.2 Operational

6.2.1 Hydrological

A brief operational monitoring effort may be adequate to establish the dimensions of the thermal plume. According to the modeling results (Section 5.3.2.1), a number of close-in sampling stations would be needed. The work would be a part of the physical and chemical monitoring (Section 6.2.5). If found necessary, such efforts will be included in the program required by the NPDES Permit.

6.2.2 Radiological

No change has been made in this section of the FES.

6.2.3 Meteorological

No change has been made in this section of the FES.

6.2.4 Ecological

As with pre-operational monitoring, EPA now has the lead in establishing the nonradiological aquatic monitoring programs (see NPDES Permit, Part III.0). The operational aquatic monitoring program would be conducted in accordance with the Environmental Protection Plan to be issued by the NRC as part of the Operating License and the NPDES Permit issued by EPA or the State of Tennessee.

No change has been made in this section relative to the applicants' tentative terrestrial program.

6.2.5 Chemical and Physical

No change has been made in this section of the FES.

6.2.6 Socioeconomic

No change has been made in this section of the FES.

6.3 Related Programs and Studies

No change has been made in this section of the FES.

6.4 Conclusion

The applicants have made various minor changes in their monitoring programs to improve the quality of the data obtained and have provided additional information in amendments to their Environmental Report. In evaluating the additional information, the staff has not found substantial changes that would alter significantly its assessments of environmental impacts in the FES (see Chapters 4 and 5).

7 ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS

7.1 Plant Accidents Involving Radioactive Materials

No changes have been made to pages 7-1, 7-2, 7-5, and 7-9 in the FES.

7.1.1 Classification of Accidents

No changes have been made to the first six paragraphs of the text.

In FES Table 7.1, the following changes have been made: "S-G leaks" is corrected to "SG tube rupture"; in the note for RAPS, "core" has been corrected to "cover"; and in the note for EVST, "in" has been corrected to "for."

The third sentence in the seventh paragraph of Section 7.1.1 has been corrected to read: "The staff is of the opinion that these requirements can be met (other guidance in the letter is being reconsidered)."

The first sentence in the footnote to the seventh paragraph has been corrected to: "*Radiological health and safety hearings are expected to be held in 1983." In the sixth sentence of the eighth paragraph, "Direct Heat Removal System" is corrected to read "Direct Heat Removal Service."

The 11th paragraph has been corrected to read as follows:

A final illustration concerns the manner in which the containment system would be protected from the effects of sodium releases in the equipment cells, particularly those cells containing the main heat transport system equipment. Sodium released into these cells would react with the oxygen in the cell atmosphere and the combustion would increase cell temperatures and pressures, especially if the release were a sodium spray. The containment design basis, including the inner cell system, must envelope the pressures and temperatures resulting from a spectrum of sodium spray and pool fires. The staff's present view is that these effects are not coupled with any sodium-concrete reactions because the applicants have proposed that the steel cell liners be engineered safety features. The staff considers it feasible to implement provisions to satisfy the design-basis requirements, such as by providing adequate cell structural capability, controlled venting of the cell, and decreased cell oxygen content. To provide accommodation against accidental releases of sodium, the applicants have committed to a cell design pressure of 30 psig, and the staff is evaluating the safety adequacy of the applicants' proposal.

The footnote to the 12th paragraph is out-of-date and therefore has been deleted.

The footnotes to Table 7.2 are unchanged with these exceptions:

In footnote 10, after the first sentence, the following has been inserted: "The selection of this source term is discussed in the June 1982 Site Suitability Report (NUREG-0786)." The following is inserted at the end of footnote 10: "A comparison of the bone dose conversion factors used in Regulatory Guide 1.109 with the ICRP-30 conversion factors for the bone surface indicates that, as a maximum, the bone surface dose values might increase by a factor of about 3 above those reported for bone."

At the end of footnote 11 this sentence has been added: "See Appendix J, Addendum to Section 7.1."

7.1.2 Comparison of Probabilities of Class 9 Events: LWRs vs. CRBRP

No changes have been made to this section of the FES, except the first sentence, which has been corrected to read:

The staff has considered the information available at this time concerning assessments of very unlikely accidents and events involving multiple successive failures, particularly those which may result in core melting or severe core damage (see FES Table 7.3; see also Appendix J for a discussion of the probabilities and releases).

7.1.3 Consequences of Class 9 Accidents

At the end of the first paragraph the following has been added: "Alternative guidelines are also being considered, in lieu of the 24-hour requirement."

In the fourth (final) paragraph, the third-from-last sentence beginning "the consequences..." has been deleted.

At the end of Section 7.1.3 this new paragraph has been inserted:

Appendix J, Addendum to Section 7.1, provides a significantly more detailed discussion of the probabilities and potential consequences of severe accidents, which may be compared to the descriptions of such probabilities and consequences for LWRs in recent environmental statements. In the appendix the staff has evaluated the environmental impacts of severe accidents including potential radiation exposure to the population as a whole, the risk of near-and long-term adverse health effects that such exposures could entail, and the potential economic and societal consequences of accidental contamination of the environment. The overall assessment of environmental risk of accidents, assuming reasonable protective action, shows that it is not significantly different from the risk from light water reactors currently being licensed for operation, and the conclusions reached in the 1977 FES remain unchanged by this evaluation.

Appendix J also includes a discussion of liquid pathway impacts for accidental releases, and the economic risks of loss of the facility as a result of accidents.

7.1.4 Accidents: Conclusions

This section of the FES and the conclusions expressed in it remain unchanged.

7.2 Transportation Accidents Involving Radioactive Material

The following discussion of transportation accidents replaces Section 7.2 of the FES. This evaluation is similar in most respects to the earlier assessment; however, it differs primarily in two ways: (1) This evaluation recognizes that DOE fuel cycle facilities would be used to support the CRBRP rather than largely commercial facilities as assumed in the FES; and (2) NRC regulations in 10 CFR 71 and similar DOT requirements (49 CFR 173) relative to radioactive shipments have been updated since the FES was issued.

Evaluation of the potential accident risks from transportation of radioactive materials in the CRBRP fuel cycle requires an assessment of the probability and consequences of an accident. Statistics are readily available on accident frequencies for both truck and rail transport. However, accident consequences cannot be evaluated on a statistical basis because of the paucity of data. In the 10 years from 1971 to 1980, only five accidents resulted in release of radioactive material. These releases involved materials of low radiological hazard that were not required to be in accident-resistant packages. No deaths or other significant health effects due to radiation exposure were experienced in any of these release events.

Available statistics indicate that the probability of an accident occurring in transportation is small and decreases with increased severity of the accident. An accident in which some Type A package¹ containment, such as a steel drum containing low level wastes, may be breached occurs about once per 2 million vehicle kilometers for truck shipments. Extremely severe accidents occur very rarely: once in 800 million vehicle kilometers for truck shipments and once in 5 billion vehicle kilometers for train shipments (NUREG-0170). Using these statistics and the estimates of truck and rail shipments per year as reported in Appendix D for the CRBRP fuel cycle, frequencies of accidents involving CRBRP shipments were estimated. Accordingly, an accident that might result in a container breach for CRBRP low level waste transported in Type A packages would occur once in 50 years. An extra severe accident that could result in a container breach of Type B packages² associated with the CRBRP fuel cycle would occur less than once in 2800 years for truck shipments and less than once in 40,000 years for rail shipments. Type B packages, such as a cask containing spent fuel, are designed to withstand severe accident environments.

¹A Type A package contains only a small quantity of radioactive material in packaging (see 49 CFR 173.389(j)) that is adequate to prevent loss or dispersal of the radioactive contents under normal transport conditions but not necessarily under accident conditions.

²A Type B package is radioactive material in packaging that meets the standards for Type A packaging and meets the standards for hypothetical accident conditions of transportation, as prescribed in 49 CFR 173.398(c), without release of contents.

Even though a radioactive release resulting from a transportation accident is unlikely, such an event could conceivably happen. Therefore, an examination of the potential consequences of an accident involving material release has been performed for each class of materials transported in the CRBRP fuel cycle. Transportation accident risks associated with shipments of fresh fuel materials are not considered to be significant because of the inherent nature of the material and the measures taken to prevent releases of radioactivity and nuclear criticality in such accidents. Depleted uranium hexafluoride is shipped from gaseous diffusion plants to the blanket fabrication plant. It is classified as a low specific activity material under the regulations of the DOT and is shipped in steel cylinders. Uranium dioxide is produced from the depleted uranium hexafluoride and may be shipped either in powder or pellet form. The consequences of a release of either of these materials to the environment, should it occur, would be limited by the low level of radioactivity of the material.

The CRBRP fresh fuel rods and assemblies would be shipped in special containers designed for that purpose. In the event of a package breach, the consequences would be expected to be small because the material is confined within the fuel cladding and is in a form that is not readily dispersible. Radiological consequences of accidents to shipments of fresh fuel materials for LWR and MOX fuel were discussed in WASH-1238 (AEC 1972) and NUREG-0002, respectively, and were found to be insignificant. Accidents to shipments of fresh CRBR core fuel materials and fuel would be expected to have similarly insignificant consequences because of design similarities.

The CRBRP irradiated fuel assemblies and other irradiated material would be transported to or from the reprocessing plant in heavy shielded casks on rail cars. The irradiated assemblies would generate significant amounts of heat and penetrating radiation after removal from the reactor core. They would be stored at the plant for a minimum of 100 days to permit decay of short-lived isotopes before being shipped to the reprocessing facility. The spent fuel cask is planned to be designed to carry relatively hot assemblies and to be built to current standards using proven technology. Each cask would be designed and constructed so that there is little probability of it being breached in an accident. The form of the nuclear fuel is such that, should a breach occur, releases of solid radioactive materials are unlikely; those releases that might occur are likely to be limited to gases and liquid coolant present in the cask cavity. (The use of sodium as a cask coolant was not proposed by DOE or considered by the staff. In the event that its use is projected in the future, any potential effects of explosion and fire would have to be analyzed.) The uranium, actinides, and most of the fission products would remain in the oxide pellets. Some of the gases and most of the volatile and semivolatile actinides and fission products released from the oxide pellets would be retained within the cladding in the void spaces in the rods. Rupture of a fuel rod would release some of the gases and volatile products into the cask cavity and coolant. However, because of the cask design and quality control measures to ensure a high level of containment integrity and the nature, form, and physical properties of the fuel assemblies, the probability of a significant radiological release is small (NUREG-0002).

The CRBRP fuel would be irradiated to greater exposure than typical LWR fuel (up to about 80,000 megawatt-days/MT exposure for CRBRP fuel vs. 30,000 megawatt days/MT for LWR fuel). Based on ORIGEN 2 calculations performed by ORNL

for the NRC, calculated radioactivity of LWR and CRBRP fuels was estimated to be similar for the period from discharge through cooling periods of up to 100 years in NUREG/CR-2762. Hence, the analyses and conclusions of previous environmental assessments for transportation of irradiated LWR fuels (WASH-1238, NUREG-0002) appear to be applicable to accidents involving irradiated CRBRP fuel. The casks designed to transport spent CRBRP fuel would be subject to DOT regulations given in 49 CFR 173. There have been no reported accidents to date with LWR spent fuel shipments by rail (McClure 1981).

Radioactive wastes from the fuel fabrication plants, the CRBRP, and the reprocessing plant would include low level wastes in the form of compactible solids and concentrated liquids, transuranic contaminated materials, and high level wastes. These radioactive wastes would be solidified and packaged for shipment to a commercial low level waste burial ground or a Federal repository as appropriate. Shipments of high level and transuranic (TRU) waste would contain the greatest radioactivity, about $6E+6$ and $7E+5$ Ci/shipment, respectively (see Appendix D, Table D.15).

Regulations define packages and performance requirements for radioactive materials (49 CFR 173 and applicable DOE Orders), depending upon the radioactivity content of the package. Non-TRU, low level waste, as low specific activity material, may be shipped in Type A packages that are designed to prevent loss of the contents under normal transport conditions but not under accident situations. Thus, Type A packages containing LLW material might be ruptured in an accident with the possibility of release of radioactivity. The solid form of the material reduces the likelihood that significant dispersal of radioactive material would result. In any event, accidental exposures would be limited to low levels as shown in NUREG-0116.

Other more highly radioactive wastes are required to be shipped in Type B packages that are designed to contain the contents under severe accident conditions including fire and immersion in water. Only in the event of extremely severe accidents would radioactivity be expected to be released from Type B packages. Even in such an event, the solid, noncombustible, nonreactive form of the contents and the hardness of the package would limit the radioactive release so that the environmental impact would be small.

The applicants indicate that wastes containing metallic sodium coolant used at the CRBRP would be stored on site. If these materials were required to be transported for disposal at some future date, they would be treated to nullify the chemical reactivity of the sodium before being transported.

High level wastes (HLW) from fuel reprocessing would be solidified and packaged in sealed canisters that in turn would be enclosed in a shielded shipping cask. The shipping cask for HLW is anticipated to be similar in design to the cask used for shipping spent fuel and is required to be constructed to withstand accident conditions. It is extremely unlikely that this cask could be breached even if involved in an accident. Also, the high level wastes are postulated to be incorporated into nondispersible, stable, solid material (for example, borosilicate glass) and sealed in separate canisters within the cask. If the cask were to be breached, high radiation exposure might occur only in the immediate vicinity of the accident because of the nondispersible nature of the material.

The consequences of an accident involving radioactive material are further mitigated by the procedures that carriers are required to follow. These procedures include segregation of persons from packages and materials and immediate notification of the shipper, DOT, and DOE in case of an accident, fire, or leaking package.

Considering the low probability of a shipment of radioactive material being involved in an accident, the requirements for package design and quality assurance, the nature and form of the radioactive material, and the control exercised over the shipment during transport, the staff concludes that transportation accidents involving radioactive material from CRBRP present a low risk of fatality or other serious health effects from radiation exposure. This conclusion is essentially the same as that in Section 7.2 of the FES.

7.3 Safeguards Considerations

The following discussion of safeguards and revised Appendix E replace Section 7.3 and Appendix E of the FES. These have been updated in recognition of two facts: (1) that DOE fuel cycle facilities would be used to support the CRBRP rather than largely commercial facilities as assumed in the FES; and (2) that upgraded NRC physical security requirements for nuclear power reactors (10 CFR 73.55) and facilities possessing formula quantities of special nuclear material (10 CFR 73.45 and 73.46) have been put into effect.

Potential abnormal environmental impacts could occur during CRBRP operation as a result of (1) acts of sabotage directed at the CRBRP itself or at materials during transport, or (2) thefts or diversion of plutonium from CRBRP, its associated fuel cycle facilities, or transportation links.

Safeguards are defined as those measures employed to prevent the theft or diversion of special nuclear materials and to protect against sabotage of nuclear facilities. Special nuclear material (SNM) is defined as plutonium, uranium-233, or uranium enriched in the 235 isotope. The only SNM in the CRBR fuel cycle would be plutonium.

The staff's assessment of DOE's proposed CRBRP fuel cycle safeguards systems is in Appendix E, "Safeguards Related to the CRBR Fuel Cycle and Transportation of Radioactive Material." Because many of the facilities are conceptual in nature, general safeguards criteria were used to perform the assessment. Individual assessments were performed for all CRBRP fuel cycle activities that would involve the handling of plutonium, including initial plutonium conversion, fuel fabrication, spent fuel reprocessing, waste management, all transportation activities, and the operation of the CRBRP. In addition, Appendix E evaluates the reasonableness of the safeguards system costs estimated by DOE.

The staff believes that the environmental impact of a successful theft of plutonium or act of sabotage could range from insignificant to severe. The staff has evaluated DOE's proposed safeguards systems, which are designed to minimize the likelihood of such events, and has concluded that the probability of successful theft, diversion, or sabotage is low and, therefore, the risks associated with these events do not represent a significant increase over the risks associated with currently operating facilities. This conclusion is essentially the same as that in Section 7.3 of the FES.

8 NEED FOR THE PROPOSED FACILITY

8.1 Historical Background of the LMFBR Program

A supplement to ERDA-1535, the LMFBR Program Final Environmental Impact Statement (PES-Supplement), has been issued (DOE-EIS-0085-FS, May 1982) that focuses on changes in the program since 1975. Appropriate excerpts quoted below add to the discussion in the FES:

In April 1977, the previous Administration deferred any U.S. commitment to advanced nuclear technologies that were based on the use of plutonium. In addition, it decided that the U.S. would defer indefinitely commercial reprocessing and recycling of plutonium. Consequently, that Administration proposed to cancel the Clinch River Breeder Reactor Plant (CRBRP) project. Research and development activities were to be continued. At ERDA's request, the U.S. Nuclear Regulatory Commission (NRC) suspended the licensing proceedings regarding the CRBRP. Congress, however, continued to authorize the appropriate funds for CRBRP, and design and component fabrication activities have continued until the present. At the present time, design work is about 90% complete and about 60% percent of the hardware has been delivered or is on order, amounting to about \$600 million.

Though work on the CRBRP was significantly slowed over the intervening years, very significant progress was made in other elements of the LMFBR program. For example, the Fast Flux Test Facility, a major fuels and materials test reactor, was brought to initial criticality in February 1980 and, having undergone a successful startup test program, is now being operated at full reactor power.

The decisions made by the previous Administration were modified on October 8, 1981, when President Reagan announced that he was lifting the suspension on commercial reprocessing and directing government agencies to proceed with the demonstration of breeder reactor technology, including completion of the CRBRP.

The LMFBR program described in ERDA-1535 contemplated gradual scale-up of demonstration facilities with government participation both in early commercial breeders and ultimately in making a decision with respect to the acceptability of widespread commercial deployment of LMFBR technology. There have been changes to the emphasis of this program, the most important of which is that the decision on deployment and commercialization of the LMFBR will be made by the utility industry. The government role will be limited to early development of the technical, engineering, and industrial base needed to lower risks and uncertainties to levels consistent with normal commercial ventures....

Current LMFBF development planning includes, among other things, the construction and operation of the intermediate-size Clinch River Breeder Reactor Plant (CRBRP) as soon as possible, and the near-commercial size Large Developmental Plant (LDP). Because of the long lead-times involved, even with vigorous pursuit of this plan, a commercially viable LMFBF and significant LMFBF market penetration are decades away. Although there is uncertainty as to precisely when the LMFBF will be economically competitive with alternatives, prudent planning indicates that LMFBF development should be geared toward potential deployment early in the next century. This necessitates that the program progress expeditiously even at the risk of developing the option before it is economically competitive with LWRs. The consequences of early development, however, are minor compared to the risk of possible electricity shortages and economic penalties associated with late development. Furthermore, significant program delays may destroy the continuity that is essential to any high technology development program.

8.2 Role of the Demonstration Plant

As indicated above, a decision on the development and commercialization of LMFBFs is now intended to be made by the utility industry with government providing early development of supporting technical bases. This change, however, does not alter the role of the CRBRP.

8.3 The Ability of CRBRP To Meet Its Objectives

This section of the FES is unchanged except as follows:

Technical Performance and Reliability - The record of performance of the major breeder reactors has been extended considerably since the FES was issued. Except for major shutdowns in 1977 to repair intermediate heat exchangers and for normal refueling/maintenance outages, Phenix (see Table A8.1) has operated continuously from 1975 to the present. The Prototype Fast Reactor (PFR) has operated essentially continuously from 1977 to the present, except for one major shutdown of about 8 months. In the Soviet Union, BN-350 has operated extensively since 1973 and BN-600 commenced operation in 1980. Japan placed its Joyo plant in operation during 1977 and has broken ground for its successor, Monju. While construction is continuing on its SNR 300, West Germany is reviewing its plans for future LMFBFs, as is Great Britain. Experience gained from the operation of these foreign breeder reactors is providing useful information about their particular designs.

Confidence in U.S. capability is based on continuing EBR-II performance after 19 years of operation and the recent FFTF startup and operation at full power (Longenecker, 1982b). EBR-II operated at 71 to 77% capacity and supplied electrical power while serving as a fuels and test facility from 1976 through 1980.

The FFTF reactor, with which fuel element reliability and performance are being studied, began operating in February 1980. It achieved full power in December 1980 after remarkably few systems or component problems during the ascent to

Table A8.1 World-wide fast breeder reactor plants

Name	Country	Power (megawatts)		Pool or loop	Initial operation
		Thermal	Electric		
<u>Decommissioned</u>					
Clementine	USA	0.025	--	Loop	1946
Experimental Breeder Reactor-1	USA	1	.02	Loop	1951
BR-1/BR-2	USSR	0.1	--	Loop	1956
LAMPRE	USA	1	--	Loop	1961
Fermi	USA	200	60.9	Loop	1963
SEFOR	USA	20	--	Loop	1969
Dounreedy Fast Reactor	UK	60	14	Loop	1959 ^b
Rapsodie	France	20/40 ^b	--	Loop	1966 ^b
<u>Operable</u>					
BR-5/BR-10a	USSR	5/10 ^a	--	Loop	1959 ^a
Experimental Breeder Reactor-II	USA	62.5	18.5	Pool	1963
BOR-60	USSR	60	12	Loop	1969
BN-350	USSR	1000	150 ^c	Loop	1972
Phenix	France	567	250	Pool	1973
Prototype Fast Reactor	UK	600	250	Pool	1974
Joyo	Japan	50/100	--	Loop	1977
KNK-II ^d	W. Germany	58	20	Loop	1977
FFTF	USA	400	--	Loop	1980
BN-600	USSR	1470	600	Pool	1980
<u>Under Construction/Procurement</u>					
Superphenix 1	France	2900	1200	Pool	1983
Prova Elementi di Combustibile	Italy	135	--	Loop	1983
Madras FBTR	India	42	17	Loop	1983
SNR-300	W. Germany ^e	770	312	Loop	1985
Monju	Japan	714	300	Loop	1987
CRBRP	USA	975	350	Loop	1990

^aInitially operated at 5 megawatt thermal as BR-5; upgraded to BR-10 (10 megawatt thermal) in 1973.

^bInitially operated at 20 megawatt thermal; power increased to 40 megawatt thermal with "Fortissimo" core.

^cAlso produced the equivalent of 200 megawatt electric as process steam for desalination.

^dOperated 1971 through 1974 as a thermal reactor, KNK-I.

^eIn cooperation with Belgium and the Netherlands.

power and preoperational testing phases (Horton, 1982). The first FFTF full-length operation cycle (100 days at full power) was initiated in April 1982.

It is the staff's judgment that the additional experience accumulated with LMFBRs, outlined above, tend to support its conclusions in the FES that CRBRP can meet its technical programmatic objectives under the LMFBR Program.

Safety - No credit has been given for natural convection circulation for decay heat removal in CRBRP because there has been no demonstration of this process on the geometry and scale of the CRBRP reactor system. However, a testing program to study natural circulation effects in the FFTF was carried out during 1981. The results of this program are being evaluated through current computer codes to determine their applicability to the CRBR system for sodium coolant circulation.

The CRBRP core design has been modified to include internal breeding blankets. This introduces a degree of heterogeneity that complicates the analysis of bowing, Doppler, and local reactivity effects. The CRBRP in its current heterogeneous design will be a valuable demonstration of the ability to calculate complex fast reactor systems.

Timing - The DOE supplement to the ERDA PES emphasizes that the timing objective of the CRBRP is to complete its construction "as expeditiously as possible." Operation of the plant is now scheduled to begin early in 1990, as shown in Figure A8.1 (PES-Supp Fig 2), which replaces FES Figure 8.1. However, the DOE plan is less specific as to the timing of the overall program, reflecting current uncertainties about projected growth of electrical demand and the transfer of the commercialization decision to private industry. The program visualizes a successor to the CRBRP called the Large Developmental Plant (LDP), which would begin operation at an unspecified date in the 1990s. Work on the LDP is not currently being funded.

8.4 Technical Alternatives to the CRBRP

A revised list of fast breeder reactor plants world-wide is given in Table A8.1. Section 8.4.7 has been added.

8.4.1 Pool Type Reactors

No changes have been made to this section.

8.4.2 Advanced Fuels

No changes have been made to this section.

8.4.3 A Different Size Plant

No changes have been made to this section.

8.4.4 FFTF Role Expanded

No changes have been made to this section.

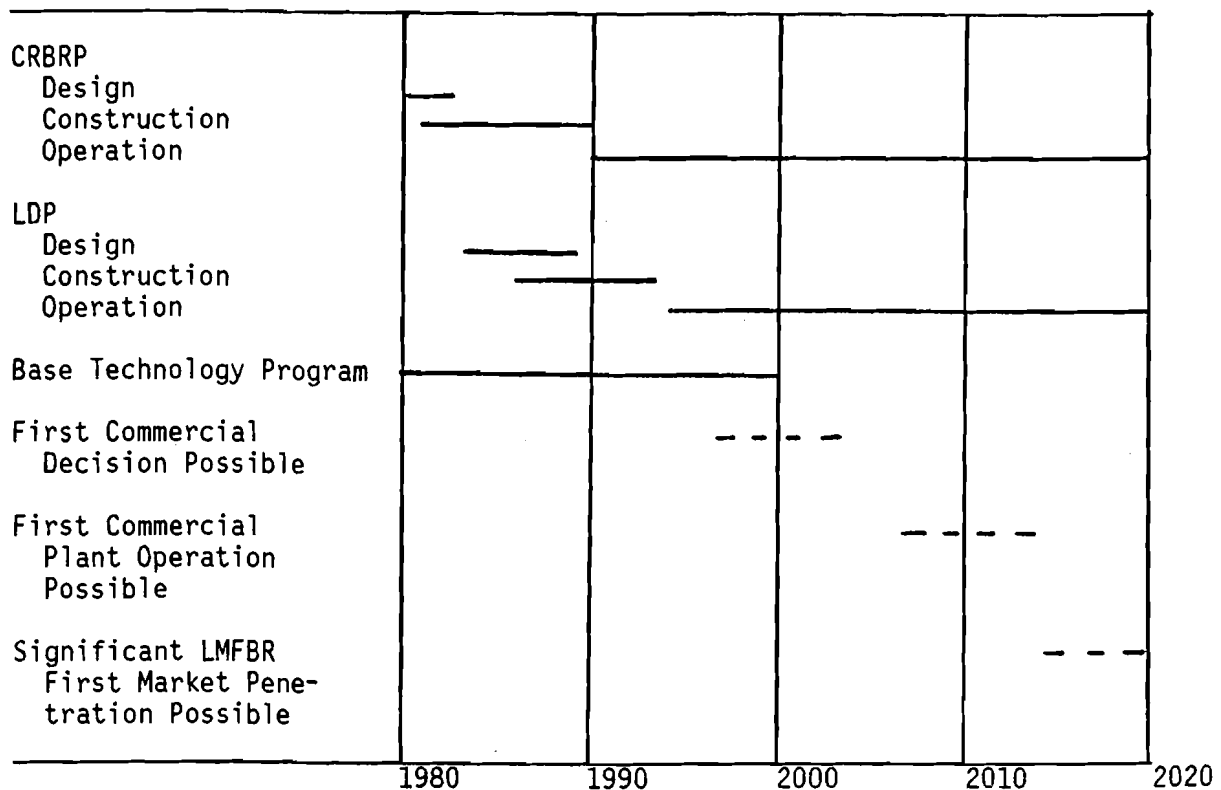


Fig. A8.1 - LMFBR development schedule (replaces FES Fig. 8.1)

8.4.5 Base Loading as a Performance Goal

No changes have been made to this section.

8.4.6 Foreign Purchase of a Demonstration Plant Design or Technology

No changes have been made to this section.

8.4.7 Nonproliferation Alternatives

(This is a new section.)

The Nonproliferation Alternative Systems Assessment Program (NASAP), undertaken in 1977-1979, and its counterpart study, the International Fuel Cycle Evaluation program (INFCE), were primarily motivated by considerations related to safeguarding fuel materials against diversion to weapons programs by developing technical alternatives to the traditional lines of reactor and fuel cycle development. Because the efficient utilization of natural resources and the technical feasibility of proposed variations were included, the studies were fairly comprehensive. It became clear that none of the proposed alternatives was entirely suitable to meet the goals of the program. A summary of the

conclusions of the NASAP and INFCE programs is given in Section VI.a.(2) of the DOE PES Supplement.

It is clear that the CRBR system, and fast reactors in general, can adopt different fuels and reprocessing schemes, so that if such variants are judged to be required, there is some flexibility for their accommodation.

8.5 Summary and Conclusion

Additional information presented in this chapter is cumulative and does not result in significant changes in the staff's assessment of the CRBRP's environmental impacts.

The staff's conclusions stated in the FES remain essentially the same, even though the timing of the CRBRP has changed, based on the Commission's decision (NRC, 1976) that the need for the LMFBR program, including its objectives, structure, and timing, is established by the ERDA (DOE) impact statement and associated processes. The earlier scheduled startup of the plant toward the end of 1982 cannot be accomplished because of the suspension of licensing activities between April 1977 and October 1981. The staff believes it is feasible to meet the new startup date of February 1990, which has been established by DOE under the LMFBR Program (PES Supplement, 1982).

9 ALTERNATIVES

9.1 Energy Sources

There have been no changes to this section.

9.2 Sites

9.2.1 Background

There have been no changes to this section.

9.2.2 TVA Site Selection Criteria

There have been no changes to this section.

9.2.3 Alternative Sites for the Hook-on Option

Since the FES was issued in 1977, the design of CRBRP as a complete new plant has progressed to such an advanced stage that reworking the design for the hook-on option would result in substantial economic and schedular penalties (Longenecker, 1981). For that reason, the applicants no longer consider the hook-on arrangement to be viable. The staff agrees with that position (see Section 9.2.5).

9.2.4 Alternative New Sites in the TVA Service Area

At the staff's request, upon resumption of the CRBRP licensing review in the fall of 1981, the applicants augmented their discussion of alternative sites in the ER in the context of NRC's Proposed Rule on Alternative Sites (45 FR 24168-24177, April 9, 1980; see Appendix K). The proposed rule is one of the principal references currently used by the staff as guidance in its review of alternative sites for nuclear power plants. Although the proposed rule was developed to ensure that environmental factors are appropriately considered in siting commercial nuclear power plants, the staff believes the guidance therein is generally appropriate for review of alternative sites for the LMFBR demonstration plant because one of the project objectives is to demonstrate licensability in a utility environment.

The purpose of this review is to determine whether the applicants' proposed site represents a reasonable choice from a group of alternative sites selected by a process sensitive to environmental concerns. While the staff has used the Proposed Rule on Alternative Sites to guide its independent review of the alternative sites, the staff is bound by standards set forth by the Commission in its 1976 Order (CLI-76-13) that only alternative sites which are "substantially better" than Clinch River need be identified by the staff's alternative site selection process. The scope of the review includes analyses directed at making the following determinations:

- (1) Whether the reconnaissance level information submitted by the applicants is sufficient to support the analyses necessary to reach reasoned conclusions.
- (2) Whether the region of interest (ROI) considered is of sufficient size to reflect reasonably available environmental diversity of water bodies and associated physiographic units.
- (3) Whether the candidate sites are among the best that could reasonably be found, based on analysis of the merits of the candidate sites.
- (4) Whether one or more alternative sites is substantially better than the applicants' proposed site, based on a sequential two-part analytical test. The first part of the test determines whether any of the alternative sites is environmentally preferable to the proposed site, using a set of environmental criteria and considering the probable effects of the project. If any alternative (candidate) site is found to be environmentally preferable, the second part of the test is undertaken to determine whether that alternative site is substantially better than (e.g., obviously superior to) the proposed site when project economics, technology, and institutional factors are also considered. As part of the latter determination, the staff also considers whether locating the plant at another site would affect the project's ability to meet its programmatic objectives.

9.2.4.1 TVA's Site Selection Process

The Region of Interest

The applicants state that the region of interest considered for siting the demonstration plant was the entire TVA power service area, which includes most of Tennessee and parts of several adjacent states (Longenecker, 1982c and d). As shown in Figure A9.1, this region includes many rivers ranging in size from small to rather large and water bodies varying from free-flowing streams to impounded lakes. The physiographic units associated with these rivers include coastal plains, interior low plateaus, the Appalachian Plateau, the Valley and Ridge Province, and the Blue Ridge. Table A9.1 lists the various rivers and their associated physiographic units.

The staff agrees that the features described above provide sufficient environmental diversity to establish the TVA service area as an acceptable region of interest.

Selection of Candidate Sites

Within the region of interest, the applicants state that the original siting assessment considered the TVA steam plants for a possible hook-on arrangement and 109 potential sites for an entirely new plant (ER Appendix G). These sites were on or near the rivers identified in Table A9.1. The slate of 13 candidate sites (2 hook-on and 11 "new") was derived from the above sites on the basis of engineering considerations such as foundation conditions, water supply, flooding potential, and environmental factors such as proximity to wildlife and recreational areas. Potential sites along the Mississippi and Ohio Rivers in the northwestern part of the region were excluded because their proximity to the New Madrid high seismic zone is good reason to doubt their licensability.

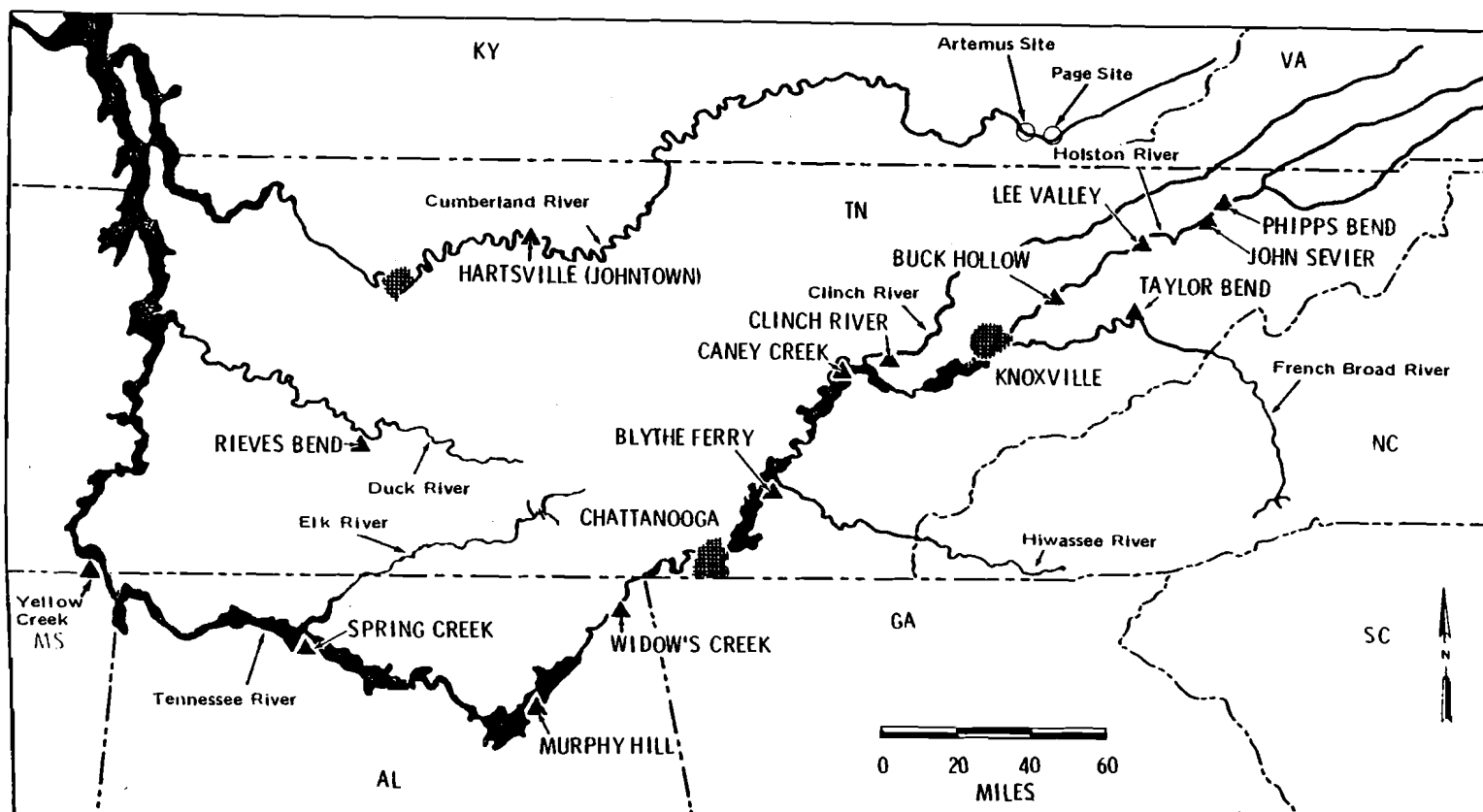


Figure A9.1 TVA region of interest and candidate sites

Table A9.1 Classification of rivers where TVA sites were considered for the LMFBR demonstration plant

River	River Type	Associated Physiographic Units
Tennessee	Large, impounded	Originates in valley and ridge and flows through Cumberland Plateau and interior low plateau to coastal plain
Duck	Small, impounded	Interior low plateau
Elk	Small, impounded	Interior low plateau
Sequatchie	Small, headwater	Appalachian Plateau
Clinch	Medium to small, impounded, headwaters	Valley and ridge
Emory	Small, impounded, headwaters	Valley and ridge
Little Tennessee	Small, impounded, headwaters	Originates in Blue Ridge and flows to valley and ridge
Tellico	Small, headwater	Originates in Blue Ridge and flows to valley and ridge
Holston	Medium to small, impounded, headwaters	Valley and ridge
French Broad	Medium, impounded, headwaters	Originates in Blue Ridge and flows to valley and ridge
Nolichucky	Small, impounded, headwaters	Originates in Blue Ridge and flows to valley and ridge
<u>Cumberland River Basin</u>		
Cumberland	Large to medium, impounded	Originates in interior low plateau and flows to coastal plain
Red	Small, headwater	Interior low plateau
Caney Fork	Small, impounded, headwater	Interior low plateau

The Green, Pearl, Barren, Coosa, Tombigbee, and Black Warrior Rivers were excluded by TVA because only their headwaters are within the ROI and these headwaters did not appear to provide adequate cooling water capabilities.

The 11 candidate new sites listed in FES Table 9.2 are also listed here in Table A9.2 with the river, river type, and character of the physiographic unit pertinent to each site. All of these sites were considered potentially licensable at the time of their selection and, since then, NRC has issued permits for construction of LWR plants at the Hartsville and Phipps Bend sites. The John Sevier and Widows Creek sites, where hook-on to existing turbines was initially considered, are shown in the table for completeness; the Yellow Creek site in the northeast corner of Mississippi, for which NRC granted a construction permit subsequent to the initial selection process, has also been added to the list as representative of the western part of the TVA power service area. As can be seen from Figure A9.1 and Table A9.2, these 14 sites reflect the environmental diversity of the feasible siting areas within the region of interest.

Guidance from the proposed rule on alternative sites (see Appendix K for the proposed Appendix A to 10 CFR 51) provides two ways of demonstrating that the sites qualify as among the best that could reasonably be found. They must either (1) be identified through the use of site-selection methodology that includes an environmentally sensitive site screening process, which, in addition, meets seven process-oriented criteria (Appendix A, Section VI.3); or (2) meet eight environmental threshold criteria (Appendix A, Section VI.2.b), in which case there shall be no further review of the site-selection process. The applicants chose the second review option and evaluated the candidate sites for conformity with the following threshold criteria listed in Section VI.2.b:

- (1) Consumptive use of water would not cause significant adverse effects on other water users.
- (2) There would not likely be any further endangerment of a state or Federally listed threatened or endangered plant or animal species.
- (3) There would not likely be any significant impacts to spawning grounds or nursery areas of significance in the maintenance of populations of important aquatic species.
- (4) Discharges of effluents into waterways would likely be in accordance with state and Federal regulations (e.g., avoidance of discharges to waters of the highest state quality designation) and would not likely adversely affect efforts of state or Federal agencies to implement water quality objectives (e.g., additional discharges to waters of currently unacceptable quality as determined by a state).
- (5) There would be no preemption or likely adverse impacts on land uses specially designated for environmental or recreational purposes such as parks, wildlife preserves, state and national forests, wilderness areas, floodplains, wild and scenic rivers, or areas on the National Register of Historic Places.
- (6) There would not likely be any significant impact on terrestrial and aquatic ecosystems, including wetlands, which are unique to the resource area.

Table A9.2 Candidate sites

Site	River	River type	Physiographic character
Spring Creek	Tennessee	Large, impounded	Interior low plateau
Blythe Ferry	Tennessee	Large, impounded	Valley and ridge
Caney Creek	Tennessee	Large, impounded	Valley and ridge
Clinch River	Clinch	Small, riverine, impounded	Valley and ridge
Taylor Bend	French Broad	Small, impounded, headwater	Valley and ridge
Buck Hollow	Holston	Medium, headwater	Valley and ridge
Phipps Bend	Holston	Medium, headwater	Valley and ridge
Lee Valley	Holston	Medium headwater	Valley and ridge
Murphy Hill	Tennessee	Large, impounded	Appalachian Plateau
Johntown (Hartsville)	Cumberland	Medium, riverine, impounded	Interior low plateau
Rieves Bend	Duck	Small, potentially impounded	Interior low plateau
John Sevier	Holston	Medium, impounded, headwater	Valley and ridge
Widows Creek	Tennessee	Large, impounded	Appalachian Plateau
Yellow Creek	Tennessee	Large, impounded	Coastal Plain

- (7) The population density, including weighted transient population, projected at the time of initial operation of a nuclear power plant, would not exceed 500 persons/mi² averaged over any radial distance out to 30 miles from the site, and the projected population density over the lifetime of the nuclear power plant would not exceed 1,000 persons/mi².
- (8) The site is not in an area where additional safety considerations (geology; seismology; hydrology; meteorology; and industrial, military, and transportation facilities) or environmental considerations for one site compared to other reasonable sites within the region of interest would result in the reasonable likelihood of having to expend substantial additional sums of money (cumulative expenditures in excess of about 5% of total project capital costs) to make the project licensable from the safety standpoint or to mitigate unduly adverse environmental impacts.

In considering the 14 candidate sites for compliance with the eight threshold criteria, the applicants found that all of the sites meet the criteria with the exception of Rieves Bend, which would not meet criteria (1), (4), and (8) relative to water sources. This finding with respect to Rieves Bend is consistent

with the staff's view expressed in the FES (p. 9-6) that the lack of an assured supply of cooling water at that site is adequate reason for its rejection. FES Section 9.2.4 indicates that several of the candidate sites would be more costly to develop, primarily because of geological characteristics, or are otherwise less desirable than the Clinch River site. However, the staff's review of information in the applicants' ER, the staff's environmental statements on various TVA projects (Hartsville, Phipps Bend, Yellow Creek, Watts Bar, Bellefonte, and Browns Ferry), and other documents (e.g., TVA's environmental statement on a proposed coal gasification plant at the Murphy Hill site) indicates that all of the candidate sites except Rieves Bend would meet the eight threshold criteria.

The proposed rule on alternative sites (Appendix K, Section VI.2.a) also indicates that the final slate of candidate sites should include: (1) at least four sites to provide reasonable representation of the diversity of land and water resources within the ROI; (2) one or more sites associated with each type of water source and physiographic unit reasonably available within the ROI; and (3) one alternative site with the same water source as the proposed site. Accordingly, the applicants have identified 4 of the 14 candidate sites (in addition to the proposed site at Clinch River) as adequately representing the diversity within the TVA region (Longenecker, 1982c), as follows:

Phipps Bend represents an acceptable site for a nuclear plant on a medium river in the headwaters located in valley and ridge areas; Hartsville represents an acceptable site on a medium river impounded in a plateau area; Murphy Hill represents an acceptable site on a large river in the Appalachian plateau; and, Yellow Creek represents an acceptable site on a large river at the junction of the Coastal Plain, the Interior Low Plateau, and the Appalachian Plateau. No alternative site on the Clinch River was included, as called for in (3) above, because none of the potential sites identified earlier on the river and upstream on Norris Reservoir emerged from the screening process as candidate sites except the proposed site near Oak Ridge (TVA, 1975).

In light of the diversity represented by the above four sites, and the fact that NRC already has considerable information about them, the applicants proposed that the staff evaluate these four representative sites to determine whether any TVA alternative sites would be environmentally preferable to the proposed site on the Clinch River. Based on their original and updated evaluations, the applicants have concluded that there are no sites in the TVA area which are environmentally preferable to the proposed site.

Staff Evaluation

The staff agrees with the applicants' view that the Clinch River, Hartsville, Murphy Hill, Phipps Bend, and Yellow Creek sites adequately represent the diversity of environmental resources within the TVA area, with the possible exception of the aquatic ecological characteristics of small river headwaters. Also lacking is an alternative candidate site on the same water source as the proposed site, as called for in NRC's proposed rule on alternative sites (Sec-VI.2.a). However, neither of these deficiencies is important to this review, in the staff's opinion, because the aquatic impacts of siting the demonstration plant on the headwaters of a small river or at another location on the Clinch River are unlikely to be less than those at the proposed site or the other candidate sites.

More than the usual reconnaissance-level information is available on the Hartsville, Phipps Bend, and Yellow Creek sites where LWR nuclear power units were under construction until TVA decided recently to postpone their completion. Since the Draft Supplement was issued in July 1982, TVA has further decided to cancel the two at Phipps Bend and two of the four units at Hartsville. Considerable information is also available on the Murphy Hill site, which is being prepared by TVA for the planned construction of a coal gasification plant (TVA, 1981b). The staff finds that the level of information (quantity and accuracy) is such that the staff can make the comparison and has a high degree of confidence that perceived advantages and disadvantages are reflective of the true situation at each of the alternative sites.

9.2.5 Selected Alternative Sites in the TVA Service Area

The staff compared the four TVA candidate sites identified in the foregoing section with the Clinch River site in Appendix L of this document (included in Appendix L are three DOE sites which are discussed in Section 9.2.6). In making this comparison, the staff assumed in the Draft Supplement that the nuclear units for which TVA has construction permits at the Hartsville, Phipps Bend, and Yellow Creek sites and the coal gasification plant planned for Murphy Hill will be completed and that the LMFBF demonstration plant would be constructed on a presently uncleared portion of each site. This would probably not be possible at the Murphy Hill site since there does not appear to be room at that site for both the synfuel plant and the breeder plant. Hence, the staff regards the Murphy Hill site to be a surrogate for similar sites in the vicinity.

In its assessments in Appendix L, the staff also considered whether significant environmental benefits could be gained from locating the plant on one of the four alternative sites if the projects partially constructed or planned at those sites were cancelled and some of the cleared areas become available. Obviously, locating the plant on the cleared areas would be an advantage even though the principal structures could not be utilized because their designs are different than the CRBRP. Possibly, the demonstration plant could utilize any water intake and discharge facilities that have already been constructed, and there may be other existing facilities that would be useful. The staff believes there would be a degree of environmental preferability for a site where site preparation has already occurred. However, it is the staff's opinion that the degree of environmental preferability would be marginal in view of the fact that the proposed CRBRP would not affect any unique land uses or special resources and because the land resources affected are of comparable quality to those in the vicinity.

Whether the cleared areas at the Hartsville, Phipps Bend, Yellow Creek, and Murphy Hill sites will become available is unknown and can only be speculated about at this time. The staff therefore considers the option of constructing the CRBRP on the cleared areas that are committed to those facilities to be equally uncertain.

As indicated in Appendix L, the characteristics of these TVA sites (including Clinch River) are roughly similar except for water availability and minor differences in potential impacts on aquatic ecology. The larger flow rates of the Tennessee River would dilute and disperse blowdown from an operating power plant more effectively than would smaller streams in the region, but the

discharge from the LMFBR demonstration plant (2432 gpm) would be so small in relation to river flow that this is not an important factor in comparing sites. The affinity of striped bass for the stretch of the Clinch River next to the proposed site during the hottest time of year would be a potentially adverse situation if there are no-flow conditions simultaneously in the river for an extended period. Because a similar situation does not exist at the alternative sites, they would appear to have an advantage in this respect were it not for the NPDES Permit requirement that the applicants demonstrate lack of impact or accept more stringent thermal limits, and the applicants' commitment to restrict thermal discharges from the plant if necessary to mitigate the impact of thermal discharges on the striped bass (Longenecker, 1982d).

The results of the staff's analyses are presented in Table L.1 at the end of Appendix L. As indicated by the composite ratings, the staff concluded that none of these TVA alternative sites would be environmentally preferable to the proposed site for construction and operation of the LMFBR demonstration plant.

Because no alternative site was found to be environmentally preferable, the staff concludes that no alternative TVA site is substantially better than the proposed site for the LMFBR demonstration plant.

Only upon identification of an environmentally preferable site would the staff normally conduct the second part of the two-stage analysis (NUREG-0555, draft revision of Section 9.2) in which economics, technology, and institutional factors are also considered in making its determination. However, because those subjects were addressed in the 1977 FES, the staff decided to update some aspects of that presentation as follows:

The staff concluded in this section of the FES that a hook-on arrangement offered potential dollar savings on the order of \$50 to 100 million. Nevertheless, the applicants and the staff found the stand-alone plant design to be preferable because its benefits were perceived to be significantly greater. Today the potential dollar savings for the hook-on plant no longer exist, and, in fact, substantial economic and schedule penalties would result if this option were pursued (Longenecker, 1981). Plant investment expended for CRBRP through 1981 totals 21.2% of the total plant cost (Table A10.3), which is equivalent to \$530 million. This represents a sunk cost in equipment and design, a large part of which would not be suitable for a hook-on plant. In addition, the hook-on facilities would now be 6 years older than during the FES review, resulting in decreased reliability and remaining life. These penalties would result because outlays for much of the site and plant design costs as well as equipment for the stand-alone plant have continued over the years, thus making the to-go costs and scheduling requirements for this option far more cost effective than for the hook-on option.

Assuming that TVA would agree to continue in the same role it now has at the Clinch River site, the programmatic objective of utility participation would be satisfied for any site within the TVA power service area. However, the applicants state that the programmatic timing objective for the demonstration plant (that it be completed as expeditiously as possible) cannot be met if a decision is made to locate the plant at a different site (Longenecker, 1982d). DOE estimates that such a change of location would delay the project a bare minimum

of 33 months to a more probable 43 months from the time a decision is made to change sites (see FES Section 9.2.6.1).

The applicants have made a recent cost comparison of locating the demonstration plant at an alternative TVA site (Table A9.3, which supersedes FES Table 9.4). A range of cost differences was provided to encompass any possible TVA alternative site. Item 1 in the table is the additional escalation of the Clinch River year-of-expenditure costs due to the 43-month-delay period. Item 1 does not include escalation on the increased costs resulting from relocation to a different site (other items in the table) with the exception of item 16, reduced revenue from the sale of power.

Table A9.3 Applicants' estimated cost impact of relocating CRBRP to an alternative TVA site--reference 43-month-delay case

Item	Incremental cost \$ (million)
1. Escalation	601
2. Staff and Support Stretch Out	164
3. Equipment Procurement	7-36
4. Relocate Project Office	0
5. Additional Travel	1
6. Difference in Prevailing Labor Rates	0-137
7. Site Studies - Other than Geological	1
8. Site Studies - Geological	7
9. Site Work Package	3
10. Seismic	11-162
11. Foundation Materials and Walls	2
12. Site Adaptation Redesign	10-88
13. Excavation	0-6
14. ER Rework	1
15. PSAR Rework	1
16. Reduced Revenue from Sale of Power	0
Maximum Range of Cost Impacts	809-1210

Source: Longenecker, J. R., letter to P. S. Check, NRC, Table 3, May 28, 1982.

Typically the staff employs a computer program (CONCEPT) (Hudson, 1979) to develop an independent check on the reasonableness of an applicant's capital investment cost estimate. An attempt was made to apply CONCEPT to the CRBRP; however, the results are viewed as indeterminate. The staff does not feel it can derive a meaningful independent estimate in this instance because of a number of differences between the breeder reactor and the light water reactor technologies for which the CONCEPT code is applicable.

9.2.6 Alternative TVA Sites Outside Its Service Area and Alternative DOE Sites

This section of the FES has not been changed except as noted below.

DOE has reviewed the screening conducted previously by ERDA of government properties in its custody and confirmed that the Hanford, INEL (Idaho), and Savannah River Plant are feasible sites for the LMFBR demonstration plant (Longenecker, 1982c, Attachment 1, Part 2). DOE stated that the only sites it has acquired since 1977 that would be of adequate size (at least 300 acres) are committed to other programmatic uses. The Nevada test site was again rejected for the reasons stated in the third paragraph on FES page 9-11.

The applicants have reexamined the data relative to the three DOE candidate sites and have again concluded that:

- (1) Atmospheric dispersion and site isolation factors (minimum exclusion boundary distance, surrounding population density) are somewhat more favorable at Hanford, Savannah River, or INEL than at the Clinch River site. However, it must be emphasized that the Clinch River site is still a completely acceptable site for construction of a nuclear facility.
- (2) A comparison of all siting parameters would not lead one to select the Hanford, Savannah River, or INEL areas as preferable to the Clinch River site.

The population figures in FES Table 9.5 have been updated to 1980 Census figures as follows:

Site	Population center	Population within 50 miles
Clinch River	27,532 (Oak Ridge)	830,840
Hanford	33,582 (Richland)	263,746
INEL	38,696 (Idaho Falls)	140,550
Savannah River	47,532 (Augusta)	~500,000

Table 9.5 in the FES has also been corrected for atmospheric dispersion at the Savannah River Reservation to read "slightly better than Clinch River" rather than "much better than Clinch River."

The applicants have also reconfirmed that utility groups in the vicinities of the above three sites are unavailable to participate extensively in the project or to operate the plant as TVA would at the Clinch River site (ER App F, Am XV).

An independent review of these three DOE candidate sites was recently made by the staff; the results are summarized in Appendix L of this document. As indicated in Table L.1 at the end of that appendix, the staff did not find any of these DOE candidate sites to be substantially better than the Clinch River site for the LMFBR demonstration plant.

9.2.6.1 Schedule Impacts

The applicants estimate a schedule delay of 43 months for relocation of the demonstration plant, the same as in the FES. The only difference is that in calculating the cost differences due to a change in site the applicants have now established October 1, 1982 rather than October 1, 1977, as Reference Time Zero for the start of their delay schedules. In the FES, the staff estimated that the delay period could possibly be reduced to as little as 27 months following an unfavorable FES on Clinch River if all means were pursued to accelerate the effort. In today's political climate, the staff believes a delay period of 36 months would be reasonable as an optimistic schedule.

9.2.6.2 Cost of Delay

The applicants' current estimates of additional cost requirements at alternative sites are summarized in Table A9.4 (which replaces FES Table 9.6). These costs are based on a 43-month delay. The escalation value shown does not include escalation on the subsequent values in the table except on item 16, reduced revenue. The applicants' cost estimates are from an appropriations standpoint and do not reflect interest during construction or present worth discounting.

For calculation purposes, to include the cost of money effects, the staff has rounded the 43-month delay period to 4 years and performed a sensitivity analysis of the economic effect of the delay period by comparing a 3-year delay case to a 4-year delay case, and used an 11% discount rate to reflect the costs in 1982 present worth dollars (Table A9.5). The effect of the longer delay period is to increase the total year-of-expenditure costs due to the additional escalation and prolonged staff support while decreasing the present worth cost since the discount rate of 11% exceeds the escalation rate of 8%. The period of delay chosen has minimal effect on the present worth cost, as can be seen by comparing the 48-month delay case to the 36-month delay case. The difference between the present worth costs between the two cases was only \$0.3 million (Table A9.5).

The staff has also revised the applicants' estimated revenue adjustments for the sale of power to reflect recent fuel cost statistics. The effect of this adjustment was a reduction in revenues from the plant at Clinch River and at each of the alternative sites except Hanford. The resulting revenues over the 7-month test and 5-year demonstration period are as follows:

<u>Revenues in Millions of Dollars</u>				
<u>Clinch River</u>	<u>Hanford</u>	<u>Idaho</u>	<u>Savannah River</u>	<u>Other TVA Sites</u>
350	1097	253	486	477

The staff assumed for the purpose of the present worth analysis that the additional "Staff and Support Stretch Out Costs" projected by the applicants would be allocated evenly over a 4-year delay period during 1983 through 1986 and

Table A9.4 Applicants' estimate of the 43-month-delay cost impact of changing CRBRP to an alternative site

Item	Incremental Cost \$ (million)			
	<u>Hanford</u>	<u>INEL</u>	<u>SRP</u>	<u>Other TVA sites</u>
1. Escalation	601	601	601	601
2. Staff and Support Stretch Out	164	164	164	164
3. Equipment Procurement	6	13	10	7-36
4. Relocate Project Office	7	6	5	0
5. Additional Travel	3	3	1	1
6. Difference in Prevailing Labor Rates	429	376	51	0-137
7. Site Studies - Other than Geological	1	1	1	1
8. Site Studies - Geological	7	7	7	7
9. Site Work Package	3	3	3	3
10. Seismic	11	11	11	11-162
11. Foundation Materials and Walls	2	2	2	2
12. Site Adaptation Redesign	10	10	10	10-88
13. Excavation	(15)	0	(6)	0-6
14. Water Supply Line	1	1	0	0
15. ER Rework	1	1	1	1
16. PSAR Rework	1	1	1	1
17. Reduced Revenue from Sale of Electricity	356	214	(27)	0
Total Cost Impact	1588	1414	835	809-1210

that the additional labor costs projected by the applicants would be allocated in proportion to the projected balance-of-plant construction for 1987 through 1993. The staff further assumed that the additional costs for other relocation and site-related activities would be evenly spread over the 1983 through 1986 delay period.

The resulting net cost differences, considering costs and revenues of alternative sites as compared to Clinch River, are summarized in Table A9.5. The Clinch River site has the lowest cost both in year of expenditure dollars and in present worth dollars. The table also shows that relocation would cost (present worth basis) \$39-303 million more at another TVA site, \$94 million

Table A9.5 NRC staff estimate of costs for location of breeder reactor at alternative sites as compared to Clinch River

Site	Year of Expenditure		1982 Present Worth	
	\$Million	% of Base	\$Million	% of Base
Clinch River (base) ¹	3,525.2	100.0	3,422.6	100.0
Clinch River ²	4,507.2	127.9	3,427.9	100.2
Hanford ²	4,353.3	123.5	3,516.3	102.7
Idaho ²	5,165.8	146.5	3,681.6	107.6
Savannah River ²	4,594.7	130.3	3,483.0	101.8
TVA Alternatives ² (high range)	4,952.4	140.5	3,726.0	108.9
TVA Alternatives ² (low range)	4,551.2	129.1	3,461.9	101.1
TVA Alternatives ³ (low range)	4,276.6	121.3	3,462.2	101.2

¹No delay

²4-year delay

³3-year delay

more at Hanford, \$259 million more at Idaho (INEL), or \$61 million more at Savannah River. As can be seen by comparing the Clinch River (base) case to the Clinch River 4-year delay case, a delay has considerable effect on the year of expenditure dollars, but little effect on the 1982 present worth cost. Thus, the period of delay chosen for the analysis is not important in comparing the present worth costs. This fact is also illustrated by comparing the 1982 present worth costs of the 3-year and 4-year delay TVA alternative (low range) cases.

9.2.6.3 Reduced Benefits of LMFBR Program

In the DOE Supplement (May 1982) to ERDA-1535 the applicants stated that they have not updated the cost-benefit analysis because key parameters (e.g., commercial LMFBR introduction dates, future nuclear capacity, etc.) used in complex cost-benefit analyses of the LMFBR are so uncertain at present that the value of such analyses would be questionable. The staff's evaluation in the FES of the benefits is no longer current, but any attempt to update it would be speculative. Nevertheless, the staff recognizes that any delay would result in reduced benefits from the CRBRP, and therefore the LMFBR program, in a present-worth context.

9.2.6.4 Radiological Risk

There have been no changes to this section.

9.2.7 Conclusion

In the first paragraph of this section, the first two sentences have been changed to read:

The staff concluded in its current evaluation of alternative sites that the DOE sites at Hanford, INEL, and Savannah River are not substantially better than the Clinch River site for the CRBRP (Section 9.2.6). Atmospheric dispersion is greater and population densities are lower at those three sites than at the proposed Clinch River site.

The remainder of FES Section 9.2.7 is unchanged except for the following:

The second and third sentences of the third paragraph have been deleted because the utility industry, rather than the ERDA administrator, is expected to make the commercialization decision at some unknown date. The last two sentences of the same paragraph have been updated as follows: "The staff currently estimates that relocation would result in an increase in the cost of the project of \$39-303 million on a 1982 present value basis and considerably more on an appropriations basis (Table A9.5). Also a reduction of the program benefits could be attributed to such a delay."

9.3 Facility Systems

9.3.1 Cooling System Exclusive of Intake and Discharge

There have been no changes to this section.

9.3.2 Intake Systems

There have been no changes to this section.

9.3.3 Discharge Systems

There have been no changes to this section.

9.3.4 Chemical Waste Treatment

There have been no changes to this section.

9.3.5 Biocide Systems

Upstream of the main condenser, continuous hypochlorite injection now is allowed to prevent colonization of algae, bacteria, and fungi in the cooling water system. This is not a significant change because of more stringent NPDES Permit limitations on discharge concentration.

9.3.5.1 Organic Biocides

There have been no changes to this section.

9.3.5.2 Ozone

There have been no changes to this section.

9.3.5.3 Mechanical Cleaning System

In the second paragraph, the specific number (0.2 ppm) for the level of residual chlorine to be discharged has been deleted because it differs from provisions of the NPDES Permit. EPA is presently establishing the applicable limitations. However, the change is not expected to be significant.

9.3.6 Sanitary Waste System

The specifications for the sanitary waste system have been revised to stipulate that it must provide treatment for a maximum of 13,000 gpd of sewage generated during operation with a staff of a maximum of 300 persons.

9.3.6.1 Tap-In to Existing Facility

This alternative has been revised to stipulate pumping waste to an existing treatment plant that has sufficient capacity to handle the additional flow.

9.3.6.2 Ground Discharge

There have been no changes to this section.

9.3.6.3 Incineration

This alternative is not under consideration.

9.3.6.4 Activated Sludge/Membrane Filtration

There have been no changes to this section.

9.3.6.5 Clarification/Filtration/Carbon Adsorption

There have been no changes to this section.

9.3.7 Transmission System

There have been no changes to this section.

9.4 Benefit-Cost Comparison

In the FES the economic cost differentials for the various alternative designs were considered. The values reported therein reflect cost analyses performed by the applicants in 1976. Since that review, no technological or economic advance has occurred that would make any one of the alternative systems more economically attractive. However, in nominal terms, these estimates understate the current

absolute difference because escalation as a result of general inflation has caused the dollar cost of all system designs to increase. In addition, because much of the design, testing, and procurement associated with the proposed plant design have already occurred, there has been a real economic shift in favor of adopting the preferred system design. Because neither of these changes would result in an improvement in the ranking of the alternatives relative to the proposed systems, the staff has not updated the economic cost estimates in this section.

9.4.1 Cooling System

There have been no changes to this section.

9.4.2 Intake Systems

There have been no changes to this section.

9.4.3 Discharge Systems

There have been no changes to this section.

9.4.4 Sanitary Waste Systems

There have been no changes to this section.

10 EVALUATION OF THE PROPOSED ACTION

10.1 Unavoidable Adverse Environmental Impacts

10.1.1 Abiotic Effects

10.1.1.1 Land

Site preparation and construction activities are now expected to disturb a total of 292 acres of land for CRBRP and 61 acres for transmission line rights of way. Approximately 113.5 acres would be dedicated on a long-term basis to plant structures and adjacent graded areas within a security barrier (37 acres), access roads and railroad (30 acres on site, 4 acres off site), a barge-unloading area (4 acres), and other facilities. These changes represent increases of 97 acres temporarily disturbed and 40 acres dedicated on a long-term basis; however, these increases in land use are insignificant compared to the total land available on the Oak Ridge reservation. As stated in the FES, all of the transmission tower bases would occupy less than 1 additional acre.

10.1.1.2 Water

Water consumed by the project is now expected to be a maximum of 210,000 gpd for construction purposes and an average of 8.3 cfs (3730 gpm) during full-power operation. These figures are higher than the 190,000 gpd and 8 cfs (3584 gpm), respectively, estimated in the FES, but these increases in water use are environmentally insignificant. The water use during plant operation would still be less than 0.2% of the annual average river flow, as indicated in the FES (Sections 4.3 and 5.2).

Plant operations would add total residual chlorine to the river at an intermittent 6 cfs rate in concentrations of up to 0.14 mg/l. This is a decrease from the 0.5 mg/l maximum concentration estimated in the FES and represents a slight improvement in the expected effect on river water quality (Section 5.4.1).

10.1.1.3 Air

The plant is now expected to discharge heat to the atmosphere at a rate of 2.26×10^9 Btu/hr at full load with the initial reactor core, or 2.5×10^9 Btu/hr at maximum design capability (Section 3.4.1). This increase of about 4% would have negligible incremental effects on the environment.

Other pollutants released because of such operation would be nitrogen oxide (22,866 lb/yr), sulfur dioxide (4083 lb/yr), carbon monoxide (819 lb/yr), and organic compounds (398 lb/yr) (Section 3.7.2). These quantities are typical for operation of diesel generators and are not environmentally significant.

10.1.1.4 Other

Reanalysis of the CRBRP socioeconomic effects in the light of current data indicates that local tax receipts would probably (instead of would not) compensate

for the increased public services needed by the work force associated with the CRBRP construction (Section 4.5.4.4). The staff recommends that the applicants monitor these effects during the construction period to determine whether additional compensation to the local communities is needed (Section 6.1.6).

The reference to "borrow pit activity" should be deleted from the second paragraph of this section since a borrow pit is no longer planned on site. The sentence has been changed to read: "Historic and archeological resources on site should not be affected if construction activities are restricted as planned (Section 4.2.1)."

10.1.2 Biotic Effects

10.1.2.1 Terrestrial

Construction would result in harvesting some timber and destruction of other plant and animal life on the 350 acres disturbed for the plant and transmission lines, rather than 260 acres as stated in the FES. Approximately 113 acres, rather than 73 acres, would be permanently disturbed. Although the numbers of biota affected would increase proportionately, the staff continues to regard the impacts on terrestrial biota as minimal in view of the fact that the amount of land affected would be less than 1% of similar land on the Oak Ridge reservation.

10.1.2.2 Aquatic

The following conclusions in this section have been modified; however no significant changes have occurred with respect to thermal, chemical, and mechanical effects on aquatic biota:

- Excavation - An area of approximately 63,000 ft² (rather than a volume of 20,000 m³ as given in the FES) of river bank and bottom temporarily would be disturbed during construction as a habitat for benthic organisms (Section 4.4.2).
- Impingement - No impact significant to the fishery in Watts Bar Reservoir would occur (Section 5.3.1.1).
- Entrainment - The phrase "losses at the average river flow of 4800 cfs would be 0.46%" has been deleted since changes in river flow, as controlled by TVA, make such a calculation inexact. As indicated in the FES, the maximum loss of plankton and drift invertebrates at low river flow would be 2.2% (Section 5.3.1.2). This level of loss would not be detrimental over the long term.
- Thermal discharge - Under normal flow conditions, fish would be able to avoid potentially harmful elevated temperatures, and mortality due to the thermal discharge would be nonexistent. Plant operation under extended no-flow conditions in the Clinch River during periods of high ambient water temperature has the potential for detrimentally impacting striped bass using this stretch of the river as a thermal refuge. This adverse combination of conditions is not expected to occur; however, the applicants have committed to restricting thermal releases from the plant if necessary to

protect the striped bass (Section 5.3.2.2), and EPA proposes a condition to that effect in the NPDES Permit (Appendix H).

Cold shock - Effects would be insignificant, as indicated in the FES.

10.1.3 Radiological Effects

Increases in the dose numbers are presented throughout the following discussion; however, these changes are primarily due to more conservative assumptions in making the calculations and do not constitute any significantly different environmental impact from that indicated in the FES.

The average annual dose to the total body of an individual living, playing, and working at the site boundary and eating fish, beef, and milk exposed to plant effluents by various pathways would be less than 1 mrem/yr. This value, which is less than 2% of the natural background exposure of 100 mrems/yr, is below the normal variation in background dose. The average dose from the plant effluents to other individuals among the population would be significantly less than 1 mrem/yr.

A total dose of about 0.1 person-rem/yr would be received by the general public in the estimated 2010 population of 910,000 living in unrestricted areas within a 50-mile radius of the plant. By comparison, an annual total dose of about 9.1×10^4 person-rem would be delivered to the same population as a result of the average natural background dose. The 1000 person-rem estimated as the annual occupational onsite exposure is about 1% of this annual total background dose (Section 5.7.3).

The annual dose of about 170 person-rem from transport of radioactive materials to and from the CRBRP and exposure to effluents from its supporting fuel cycle facilities (rather than 17 person-rem from transport and 16 person-rem from the fuel cycle, as stated in the FES) would also be nonsignificant fractions of the dose from natural background radiation (Section 5.7.3).

As indicated in the FES, the risks associated with accidental radiation exposure would be very low (Chapter 7).

10.2 Short-term Use and Long-term Productivity

10.2.1 Scope

No changes have been made to this section of the FES.

10.2.2 Enhancement of Productivity

No changes have been made to this section of the FES.

10.2.3 Uses Adverse to Productivity.

10.2.3.2 Water Usage

The value of consumptive water use has been changed from 8 cfs to 8.3 cfs.

10.2.4 Decommissioning

The following assessment replaces the discussion of decommissioning in this section of the FES. Much of the information in the FES has been updated and included here, with additional new information from generic studies of decommissioning PWRs and BWRs.

10.2.4.1 Introduction

NRC regulations do not require an applicant for a construction permit or operating license to submit decommissioning plans at the time of the application. The applicant/licensee is required to file a decommissioning plan at the completion of the operating period. An evaluation of environmental impacts is a required part of the licensee's decommissioning plan. On the basis of environmental reports and assessments of decommissioning actions accomplished to date, no unacceptable impacts have resulted from reactor decommissioning.

The CRBRP applicants have not developed any definite plan for decommissioning the CRBRP. As the CRBRP approaches the end of its useful lifetime, which is expected to be about 30 years, the applicants/licensees must submit a specific decommissioning plan for review by the NRC. The plan must comply with all NRC rules and regulations in effect at that time.

The current regulation on reactor decommissioning, 10 CFR 50.82, states the Commission requirements for dismantling a reactor and for terminating a reactor license. The current staff guidelines for evaluating decommissioning plans are set forth in Regulatory Guide 1.86 (June 1974).

NRC regulations and guidance on decommissioning are now being revised. Publication of proposed revisions to regulations is expected by February 1983. Revisions to Regulatory Guide 1.86 are expected within a year after the revisions to regulations go into effect.

A generic discussion of environmental impacts associated with decommissioning of nuclear facilities is in Draft NUREG-0586. Draft NUREG-0586 is undergoing revisions to reflect comments received; its publication in final form is expected by February 1983.

10.2.4.2 Decommissioning Alternatives

Decommissioning alternatives acceptable to the NRC staff are described in Regulatory Guide 1.86.

Mothballing/SAFSTOR consists of placing a facility in such a condition that the residual radioactivity can be stored safely to allow radiation levels to be reduced by decay. With this alternative, continuing radiation monitoring, environmental monitoring, maintenance, and access control must be accomplished at the facility. In general, with this alternative, the facility may be left intact, except that fuel assemblies, radioactive fluids, and radioactive waste have to be removed from the site. The reactor license and necessary license conditions would remain in effect until the residual radioactivity is less than or equal to the levels acceptable for unrestricted use of the site, in accordance with criteria applicable at the time of decommissioning.

Maximum surface contamination levels currently acceptable to the staff are in Regulatory Guide 1.86, Table 1. In addition, licensees are required to demonstrate by analysis that any residual imbedded activation/radioactivity in shielding structures, reactor components, or soil has been reduced to levels acceptable for release to unrestricted access. In recent decommissioning actions, gamma radiation from reactor-generated radionuclides imbedded in reactor shielding structures, reactor components, or soil has been considered acceptable to the staff if the potential exposure, as measured 1 meter from any surface, is 5 microR/hr or less (Reid, 1981). Five microR/hr above natural background is an exposure rate that is detectable with reasonable accuracy by state-of-the-art instrumentation.

The value of 5 microR/hr represents a potential exposure to an individual of 10 mrem/yr if one conservatively assumes 2000 hours per year of occupancy in a structure in which the exposure rate is 5 microR/hr.

The risk to the exposed individual is estimated by multiplying the risk estimators presented in Section 5.7.2.5 by the conservatively estimated annual total body dose of 10 millirems. This calculation results in a risk of potential premature death from cancer to that individual from 1 year of exposure of about 1 chance in 1 million. This risk is very small in comparison to natural cancer incidence from causes unrelated to the operation of CRBRP, and a very small fraction of the risk from 1 year of exposure to natural background radiation (see Section 5.7.3 for additional information).

The safe storage period may be as long as 50 to 100 years to allow significant radiation decay of cobalt 60. Cobalt 60 is the most dominant radionuclide with respect to occupational exposure during the safe storage period because of its half life, its relatively high abundance in stainless steel, the high energy of its gamma emissions, and its large dose rate per curie. The long safe storage period reduces radioactive waste quantities, exposure to workers, and exposure to the public when the reactor is eventually dismantled and the residual radioactivity is removed. At the end of the safe storage period, the facility is dismantled and decontaminated, with the residual radioactivity in excess of acceptable limits disposed of at licensed low level waste burial grounds. Certain components (the reactor internals and portions of the reactor vessel) contain some long-lived radionuclides such as niobium 94, nickel 63, and nickel 59. These components would be evaluated at the end of the safe storage period with respect to the need for disposal at a deep geologic disposal facility in accordance with NRC criteria in effect at that time. The disposal of these components containing long-lived radionuclides is being considered in the ongoing development of NRC rules and guidance regarding decommissioning.

Entombment/ENTOMB consists of sealing the remaining radioactive components within a structure integral with the biological shield after all fuel assemblies, radioactive fluids, and radioactive wastes--and in most cases the reactor vessel internals and the reactor vessel itself--have been removed. For this alternative, the entombment structure must provide a barrier sufficient to ensure adequate control when the residual radioactivity is above levels acceptable for release to unrestricted access. Levels currently acceptable to the staff are given in the third paragraph of this section (10.2.4.2). This period may be as long as 100 to 150 years. As was the case in Mothballing/SAFSTOR, the reactor license and necessary conditions would remain in effect until the residual radioactivity has decayed sufficiently or has been removed from the site, in accordance with criteria applicable at that time.

Dismantlement/DECON consists of removal of all significantly radioactive components from structures and the site so that radiation levels are consistent with NRC criteria applicable at that time. Levels currently acceptable to the staff are given in the third paragraph of this section (10.2.4.2). Most radioactive material exceeding such criteria would go to licensed low level waste burial grounds. Exceptions would be certain components such as the reactor internals and portions of the reactor vessel with the long-lived radionuclides that may have to be disposed of at a deep geologic disposal facility, as previously discussed.

10.2.4.3 Environmental Impacts

Each decommissioning alternative has some environmental impacts. SAFSTOR and ENTOMB result in the commitment of a few acres of land where the reactor structures are situated for the time that the facility remains in the safe storage or entombed status. The applicants have estimated in the ER (Section 5.9) that this could be up to 11.3 acres. All three alternatives involve the commitment of land at the licensed low level waste burial grounds for disposal of radioactive waste. In NUREG-0586 (Page 0-12) and NUREG/CR-0130, the volumes of low level waste are estimated for a 3500 Mwt PWR. NUREG-0586 estimates that the 17,900 m³ of low-level radioactive waste produced by immediate or early dismantling could be disposed of in less than 2 acres of land. After 50 years of safe storage, the volume of waste for disposal is estimated to be 1830 m³, corresponding to an area of 0.25 acre or less.

The estimates of low level waste land commitment for a 3500 Mwt PWR are adequately conservative with respect to the CRBRP because the CRBRP thermal power is one-third as large and the structural volumes are smaller than for the PWR.

Decommissioning may also involve commitment of space at a deep geologic disposal facility for disposal of components with long-lived radionuclides. In NUREG-0586 (page 0-12), this space is estimated to be 88 m³ for a 3500 Mwt PWR. This estimate is also adequately conservative for the CRBRP.

In addition, there may be a commitment of resources to ensure continued security at the licensed low level waste burial grounds. The cost of this security would, of course, be shared with the many other users of these radioactive waste facilities.

The disposal of radioactive sodium from the CRBRP cooling system is unique to breeder reactors and other sodium-cooled reactors. At Hallam and Fermi 1 (see Section 10.2.4.4) the primary system sodium was saved for use in other AEC/DOE reactor programs. A similar solution could be used for the CRBRP. The secondary system sodium could also be reused or could be sold commercially after verification that it is free of significant radioactivity, as was done at Fermi 1. If radioactive sodium must be disposed of, it would have to be converted to a less chemically active substance prior to burial.

As with the PWR, the use of SAFSTOR or ENTOMB for the CRBRP would probably result in the commitment of less land for radioactive waste disposal than DECON because much of the radioactivity in components and structures would decay in place to levels acceptable for unrestricted access. Transportation of waste material to waste burial grounds would result in increased traffic and an increased risk of exposure to the public, depending on the transportation mode.

Exposure to workers during decommissioning will be maintained as low as reasonably achievable (ALARA) by careful health physics surveillance of activities and especially by maximum use of remote operations. Some personnel exposure will result from any of the alternatives, but the SAFSTOR option would result in less exposure than DECON because radiation levels would be reduced at the time of dismantling. Decommissioning experience indicates that occupational exposures can be adequately controlled.

Although more information on possible environmental effects of decommissioning is presented here than in the FES, the staff does not find that the expected environmental effects are significantly different.

10.2.4.4 Experience

A number of licensed power reactors and demonstration nuclear power plants have been decommissioned. There is no reason to expect that decommissioning of the CRBRP would introduce any new or unknown technical problems of a safety or environmental nature.

Experience with decommissioning Fermi 1, a 200 MWt power reactor, is directly relevant to CRBRP because Fermi 1 was also a sodium-cooled breeder reactor. The Fermi reactor was decommissioned during the period from 1973 to 1975. The fuel, the depleted uranium blanket, and the sodium were removed; accessible areas were decontaminated. Fermi 1 is now maintained in a safe storage status, with continued access control, radiation monitoring, and maintenance. The fuel was shipped to the Savannah River reprocessing facility and the blanket material to a retrievable waste storage facility at the Idaho National Engineering Laboratory. The sodium was removed from the reactor primary and secondary systems. The nonradioactive secondary system sodium was sold to a commercial user. The primary system sodium is now stored in tanks and drums at the Fermi 1 site and will be held there under contract with DOE until it is shipped to the CRBRP or another DOE facility for reuse. The cost of decommissioning Fermi 1 was approximately \$4.0 million, exclusive of the core fuel use charges, fuel removal cost, and reprocessing cost. The cost related to core fuel was \$3.0 million. The Fermi licensee (Detroit Edison) estimates the cost of maintaining Fermi 1 in the safe storage mode has been less than \$40,000 per year, including 1980, the year in which the health physics building was removed. The decommissioning of Fermi 1 is described in "Retirement of the Enrico Fermi Atomic Power Plant," NP-20047, Supplement 1 (Power Reactor, 1975).

Occupational exposures were sufficiently low enough at Fermi 1 during decommissioning so that no outside contract workers were needed to supplement Fermi 1 plant personnel because of exposure levels. An NRC contractor is compiling Fermi 1 exposure data and a summary of Fermi 1 occupational exposures during decommissioning; this compilation should be available by July 1982.

The Hallam Nuclear Power Facility, a 254 MWt sodium-cooled, graphite-moderated reactor, was decommissioned by entombment during 1968 and 1969. Sodium was removed from the reactor systems, with primary system sodium transferred to the AEC site at Richland, Washington and secondary system sodium transferred to the AEC Liquid Metal Engineering Center in Santa Susana, California for further use in AEC programs. Fuel was shipped to the Savannah River plant for reprocessing.

An analysis of the residual activity at the site and the integrity of the entombment structure was performed. Potential pathways to the environment were considered and the groundwater pathway was identified as the most important. Nickel 63 was considered to be the dominant isotope for potential exposures through biological pathways 100 years after reactor shutdown. Results indicated that the maximum concentration of nickel 63 likely to occur in groundwater adjacent to the facility would be less than 1% of 10 CFR 20 limits for water in unrestricted areas (Morris, 1967). DOE performs periodic radiation monitoring at the Hallam site. The cost of the Hallam decommissioning was \$3.15 million. The decommissioning of Hallam is described in "Report on Retirement of Hallam Nuclear Power Facility" (Atomics International, 1970).

The Elk River Reactor Power Station was a 58 Mwt BWR, decommissioned by dismantlement during the period 1972 to 1974. All fuel was removed and shipped to an AEC reprocessing facility. All structures, both radioactive and nonradioactive, were removed from the site during dismantlement. Radioactive waste was disposed of in licensed burial grounds in Illinois, Kentucky, and Washington. Nonradioactive waste was disposed of in a local landfill area. All material with "detectable reactor-originated radioactivity" was disposed of in licensed burial grounds. The cost of dismantling the Elk River reactor was approximately \$6 million, and dismantling occupational exposures totaled 75 person-rems. The Elk River decommissioning process is described in "Final Elk River Reactor Program Report" (United Power).

10.2.4.5 Cost

Estimated costs of decommissioning vary, depending on the characteristics of the particular reactor, whether the reactor is on a single- or multiple-reactor site, and the decommissioning mode chosen. For a large PWR (3500 Mwt) on a single-reactor site, DECON is estimated to cost \$33.3 million (in 1978 dollars). SAFSTOR is estimated to cost \$42.8 million with a 30-year safe-storage period, and \$41.8 million with a 100-year safe-storage period. ENTOMB is estimated to cost \$21 million with the pressure vessel and its internals retained, or \$27 million with the pressure vessel and internals removed, plus a \$40,000 annual maintenance-and-surveillance cost in both cases (Table 4-3-1, NUREG-0586, and NUREG/CR-0130).

The above costs are considered to be adequately conservative with respect to the CRBRP because the CRBRP thermal power is less than one-third of the example PWR power level, and, except for removal of the sodium from the CRBRP cooling system, CRBRP decommissioning operations would involve the same level of effort as decommissioning of a PWR. The cost of removal of the primary sodium from all systems, disposal of the primary cold trap, and future shipment of the primary system sodium to DOE for reuse was estimated at \$250,000 for Fermi 1. The secondary sodium was not radioactive and was sold by the Fermi 1 licensee for commercial reuse. CRBRP is about five times the power level of Fermi 1, but the cost of handling the sodium would be expected to be no more than five times as much (about \$1.25 million in 1978 dollars).

10.3 Irreversible and Irretrievable Commitments of Resources

10.3.1 Scope

No changes have been made to this section of the FES.

10.3.2 Commitments Considered

No changes have been made to this section of the FES.

10.3.3 Biotic Resources

No changes have been made to this section of the FES.

10.3.4 Material Resources

10.3.4.1 Materials of Construction

No changes have been made to this section of the FES.

10.3.4.2 Replaceable Components and Consumable Materials

At the end of the first paragraph of this section in the FES, the maximum output of 379 MWe net should be changed to 1121 MWt.

The last paragraph have been revised as shown below:

The extent of fuel consumption over the plant's 30-year life cannot be accurately predicted because of uncertainties in the fuel recycle philosophy. Operated on a once-through fuel cycle, the total requirement could be 27 MT of plutonium and 332 MT of uranium, although the breeder capability is expected to establish much lower requirements. Under ideal recycling, the plant's lifetime uranium requirement would be 58 MT, with 27.6 MT recoverable at the time of plant decommissioning in addition to 30.4 MT previously removed. The applicants estimate that 3.5 MT of ^{239}Pu would be required for startup and that a net gain of 3.2 MT would be produced over the plant's 30-year life. Thus, 14.2 MT of depleted uranium would be consumed and there would be a net gain of 3.2 MT of bred plutonium. A supply of depleted uranium would be available as spent fuel from light water reactor power plants. About 600 MT of stainless-steel fuel cladding would become contaminated with radioactive material, making it irretrievable, since recycling is uneconomical (ER, p 3.8-3).

10.3.5 Water and Air Resources

The consumptive use of river water is now expected to be 8.3 cfs instead of 8 cfs. This amount would not curtail downstream uses, even during extremely low flow.

10.3.6 Land Resources

Thirty of the 37 acres committed to plant use could be restored for other purposes, with a moderate decommissioning effort. The 7 acres for principal plant buildings could be restored only at a high cost.

10.4 Benefit Cost

10.4.1 Benefits

10.4.1.1 LMFBR Concept Demonstration

No changes have been made to this section of the FES.

10.4.1.2 Electrical Energy Produced

The CRBRP has a nominal rating of 350 MWe, with a stretch rating potential of 402.5 MWe. This capacity and the electrical energy it provides to the TVA system is viewed as a secondary benefit. Assuming the applicants' estimate of an average annual capacity factor of 76.5% (based on 350 MWe) is realized, the plant will generate about 2.35 billion kWh per year. Over an assumed 30-year plant life, a total of slightly over 70 billion kWh could be produced. The energy generated by the CRBRP can be viewed as displacing the highest incremental cost energy available to TVA, which is expected to be coal. An equivalent amount of electricity supplied by burning coal in a steam generator would consume about 900,000 tons of coal per year (based on 2.54×10^6 tons of coal to produce 6.57×10^9 kWh (WASH-1535)).

10.4.1.3 Research

Expenditures for research and development (R&D) by DOE in support of the CRBRP are now expected to be a total \$435 million between 1975 and 2020, with about \$900 million more for safety-related R&D applicable to the total LMFBR program.

10.4.1.4 Environmental Enhancement

No changes have been made to this section of the FES.

10.4.1.5 Employment and Payroll (Secondary Benefit)

This section of the FES has been replaced by the following:

The direct payroll during the construction period is now expected to be \$446 million; it is expected to induce a secondary payroll of \$2.5 million through creation of local demand for goods and services. During the demonstration period, the \$50 million direct payroll is expected to induce a secondary payroll of \$4.4 million. The data in FES Table 10.2 have been updated, as shown below in Table A.10.1.

10.4.1.6 Taxes (Secondary Benefit)

This section has been revised in accordance with the staff's updated assessment of socioeconomic impacts.

State and local taxes generated from payroll spending would be the principal source of public funds generated by the project for use in the project area. These revenues would be generated principally in Anderson, Knox, Loudon, and Roane Counties.

The staff estimate of the value of tax revenues for the peak year of construction is summarized in Table A4.13. As indicated in that table, \$29.5 million in general fund revenues and \$66.4 million in school fund revenues would be generated in the peak year of construction.

Table A10.1 Summary of employment benefits

Item	Construction period	Demonstration period
Direct Employment ^(a)	2700	325
Induced Employment ^(a)	43	75
Direct Payroll ^(b)	\$446,200,000	\$49,800,000
Induced Payroll ^(b)	\$2,500,000	\$4,400,000

(a) Annual average based on Table A4.1.

(b) See Table A4.11 and ER Am X.

10.4.2 Cost Description of the Proposed Facility

10.4.2.1 Environmental Costs

Environmental costs discussed in Chapters 4 and 5 are summarized and updated in Table A10.2, which replaces FES Table 10.4. Vertical lines in the margins of the table indicates where changes have been made.

10.4.2.2 Monetary Costs

The applicants' current estimated cost of the CRBRP is \$3.196 billion for plant investment, development, and operation through 1995. The estimated cost breakdown is presented in Table A10.3, which replaces FES Table 10.5. The base cost estimates are in 1974 dollars without escalation. The applied escalation rate is 8%/yr. Estimated revenues for electricity sold to TVA totalling about \$680 million are credited to operating costs. The applicants' cost estimate is from an appropriations standpoint and does not reflect interest during construction or present worth discounting.

As shown in Table A10.4, the staff has revised the applicants' estimate to recognize the time value of money using an 11% interest rate. The staff also believes that applicants' estimate of revenues from the sale of power is overly optimistic and, based on recent coal cost statistics, has reduced this amount from \$679 million to \$350 million. The resulting accumulated costs by year of expenditure and in 1982 dollars are as follows:

	\$ millions	
	Year of expenditure	1982 present worth
1974 through 1982	1370	1949
1983 through 1995	2155	1474
TOTAL	3525	3423

Table A10.2 Summary of environmental costs, CRBRP

Effect	Reference section	Summary description
<u>Land Use</u>		
Construction activities	4.2.1	About 292 acres disturbed during construction of the plant and support facilities.
Long-term dedication	4.2.1	About 113 acres permanently dedicated, including 34 acres for access roads and railroad.
Transmission lines	5.5	A total of 3.2 miles of right-of-way would be widened, causing a disturbance of about 58 acres. Two streams and several intermittent streams would be crossed.
<u>Water Use</u>		
Construction	4.3	210,000 gpd maximum rate.
Operation	5.2	8.3 cfs (3730 gpm) water consumptively used during operation.
Thermal effects	3.4.1	Cooling water would be heated 22°F by passage through the condensers.
Intake velocities	3.4.2	Intake velocity is expected to be about 0.2 fps.
Discharge volume	3.4.3	Minimum rate of 1030 gpm; maximum rate of about 2432 gpm.
Chemical and sanitary waste	5.4	Rapidly diluted to harmless concentrations under flowing river conditions.
Siltation	4.3	Material to be removed for construction of access road and railroad, intake and discharge structures, and barge slip; suspended solids in site runoff would have minor, temporary effects.
<u>Terrestrial Ecological Effects</u>		
Rare and endangered species	2.7.1.2.2	The Bald Eagle, an endangered species, has been observed on the site, but no nesting activities have occurred.
	4.2.1	Rare wild flower collection areas on the site would not be disturbed.

Table A10.2 (Continued)

Effect	Reference section	Summary description
<u>Terrestrial Ecological Effects (continued)</u>		
Vegetation and animal life	4.4.1	Some timber would be harvested but other vegetation and some animals on land disturbed by construction would be lost.
Cooling tower drift	5.3.3	Worst case deposition would be 90 lb/acre/mo of salts; no adverse effect is expected.
<u>Aquatic Ecological Effects</u>		
Benthic losses		
During construction	4.4.2	Benthic organisms lost as a result of dredging and other construction activities would be easily reestablished.
During operation	5.3.2.4	The maximum scour area around the discharge would be 10 m ² and produce a permanent loss of benthos in that area.
Impingement	5.3.1.1	Negligible.
Entrapment	5.3.1.1	Negligible.
Entrainment	5.3.1.2	A maximum loss of 2.2% of phytoplankton, zooplankton, drift invertebrates, and ichthyoplankton is estimated.
Thermal effects	5.3.2.2	No significant impact on fish is expected with flow in the Clinch River. During extended periods on no flow and high ambient water temperatures, the potential exists for impacts to striped bass; however, such conditions are unlikely and the applicants have committed to restricting thermal discharge if necessary.
Cold shock	5.3.2.3	Fish loss is unlikely from any interruption of heated effluents
Sanitary waste	5.4.2	Negligible.

Table A10.2 (Continued)

Effect	Reference section	Summary description
<u>Dose from Exposure to Radioactivity</u>		
Individual	5.7.7	Less than 2 mrem/yr average annual dose to an individual at site boundary, less than 2% of 100 mrem/yr natural background dose.
Cumulative	5.7.8	About 0.1 person-rem/yr to the total body of the population within 50 miles in the year 2010 (910,000), insignificant compared to about 9.1×10^4 person-rems/yr from natural background.
Occupational	5.7.9	1000 person-rems/yr conservatively estimated, 1% of the 50-mile population natural background dose.
Transportation and fuel cycle	5.6.2.6	170 person-rems/yr, nonsignificant compared to exposure to natural background radiation.
Accidental	7.1, 7.2	The risks associated with accidental radiation exposure are very low.
<u>Community Effects</u>		
Archaeological sites	5.1	None of the several archaeological sites on the property would be disturbed by construction activities. Access to Hensely Cemetery would be allowed.
Visual impact	5.1	The structures would be partly visible from the Gallagher Bridge and scattered residences south of the river.
	5.3.3	It would be possible to have a 6-mile long plume 6% of the time during plant operation. Fog could be a minor nuisance on nearby roads a few hours per year.
New population		(deleted because this was incorrectly shown in the FES as an environmental cost)
Payroll		(deleted because this was incorrectly shown in the FES as an environmental cost)
Public services	4.5.4	No firm provisions have been made for funds to provide public sector services; however, DOE has recognized its responsibility to make payments if adverse impacts occur.
Traffic	4.5.3	Traffic congestion on State Road 58 in Roane County during construction could be mitigated by staggered shift schedules. Fogging could have a small effect on local transportation.

Table A10.2 (Continued)

Effect	Reference section	Summary description
<u>Physical Resources</u>		
Uranium	10.3.4.2	Less than 332 MT
Plutonium	10.3.4.2	Less than 27 MT

Table A10.3 Applicants' estimated cost of CRBRP through 1995

Item	Cost (\$ millions)	% of project cost expended through 1981
Plant investment		
Base	1122.3	
Escalation	1198.1	
Contingency and escalation	182.8	
Plant investment total	2503.2	21.2
Development		
Base	535.3	
Escalation	269.1	
Contingency and escalation	13.7	
Development total	818.1	77.6
Operating		
Base	146.3	
Escalation	405.2	
Contingency and escalation	2.9	
Less Revenues	(679.2)	
Operating total	(124.8)	0
Project total	3196.5	36.1

Source: Letter of May 26, 1982 to Harold Denton from applicants (Percy Brewington, Jr., DOE; William R. Rolf, PMC; and William F. Willis, TVA) amending their application for the CRBRP construction permit, Appendix G.

Table A10.4 Staff's total plant cost estimate for CRBRP
in millions of dollars

Year	YOE ¹ Dollars	PW ² Factor	1982 P.W.	Accumulated	
				YOE Dollars	1982 PW
1974	29.9	2.305	68.9	29.9	68.9
1975	70.1	2.076	145.5	100.0	214.4
1976	140.2	1.870	262.2	240.2	476.6
1977	184.4	1.685	310.7	424.6	787.3
1978	166.2	1.518	252.3	590.8	1,039.6
1979	175.1	1.368	239.5	765.9	1,279.1
1980	189.4	1.232	233.3	955.3	1,512.4
1981	199.5	1.110	221.4	1,154.8	1,733.8
1982	215.6	1.000	215.6	1,370.4	1,949.4
1983	307.3	0.901	276.9	1,677.7	2,226.3
1984	312.8	0.812	254.0	1,990.5	2,480.3
1985	293.3	0.731	214.4	2,283.8	2,694.7
1986	389.3	0.659	256.5	2,673.1	2,951.2
1987	385.4	0.593	228.5	3,058.5	3,179.7
1988	241.4	0.535	129.1	3,299.9	3,308.8
1989	148.0	0.482	71.3	3,447.9	3,380.1
1990	101.9	0.434	44.2	3,549.8	3,424.3
1991	28.7	0.391	11.2	3,578.5	3,435.5
1992	22.5	0.352	7.9	3,601.0	3,443.4
1993	(7.3)	0.317	(2.3)	3,593.7	3,441.1
1994	(31.6)	0.286	(9.0)	3,562.1	3,432.1
1995	(36.9)	0.258	(9.5)	3,525.2	3,422.6

¹ Year of expenditure dollars; includes 8% escalation

² Factor for projecting or discounting, to the end of 1982,
using an 11% discount rate.

Table 10.3 of the FES and the remaining discussion in this section of the FES have been deleted since they are now out of date.

The costs of safeguards shown in this section of the FES have been revised to a total of \$57.7 million in capital costs for measures necessary to protect the CRBRP, the related fuel cycle facilities, and transport of radioactive materials. Annual operating costs for these safeguards would be approximately \$15 million. These figures include the full safeguards costs of \$50 million capital investment and \$10 million annual operating costs for the Developmental Reprocessing Plant (DRP) because no LMFBR near-term applications have been identified other than CRBRP which would utilize its capacity (Appendix E, Section E.6.3).

Estimated costs for decommissioning would vary, depending on the decommissioning mode chosen, from about \$21 million to about \$43 million in 1978 dollars (see Section 10.2.4.5).

10.4.3 Benefit-Cost Summary

Changes have been made in items (2) and (3) in the second paragraph in this section of the FES, as shown below. These changes recognize that design and procurement for the complete plant are so far along that switching to a hook-on arrangement would no longer be less expensive. The staff's previous conclusion (3) has been deleted since reanalysis of the CRBRP socioeconomic effects in the light of current data indicates that local tax receipts would probably (instead of would not) compensate for the increased public services needed by the work force associated with its construction and operation.

On the basis of its evaluations, the staff concludes that (1) constructing and operating the CRBRP at the proposed location would be possible without causing any significant impact on the physical environment of the area, and (2) locating the project at an alternative TVA site using the hook-on arrangement would now be more expensive and the attendant technological risks could jeopardize the ability of the project to meet its intended objectives. Furthermore, on the basis that accident risks at the CRBRP site will be made acceptably low (comparable to LWR risks), the reduction in potential consequences associated with accidents at alternative sites does not warrant relocating the proposed plant when balanced against the detrimental effects of relocation on achieving the demonstration plant's objectives. The staff also concludes that the CRBRP would meet the demonstration plant's objectives within the LMFBR program (see Chapter 8).

11 DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

In updating the Final Environmental Statement related to construction and operation of the Clinch River Breeder Reactor Plant (NUREG-0139), the staff has reviewed its responses to the comments in Appendix A of the FES to ensure that the responses are also current. Where corrections have been found necessary and additional information would be helpful, they are provided below.

11.1 Summary and Conclusions, Introduction, and General Comments

11.1.1 ERDA (DOE) Involvement (CC, A-44; PMC, A-94, Encl. 2, Item 1)

DOE has succeeded ERDA as the Federal agency with overall responsibility for managing the design, construction, and operation of the plant and it will have custody of the plant and the site on behalf of the United States.

11.1.2 Operator of the Plant after the Demonstration Period (OR, A-38, Item D.1)

No changes have been made to this section.

11.1.3 NEPA Review After 5 Years (EPA, A-17, Item 3)

No changes have been made to this section.

11.1.4 State and Local Licenses and Permits (OR, A-39, Items D.5 and D.6; TN, A-25, 28)

No changes have been made to this section.

11.1.5 State Contacts with State and Local Officials (OR, A-39, Item D.4)

No changes have been made to this section.

11.1.6 Completion Date and Cost Overruns (NRDC, A-51, 52)

As indicated in the application amendment dated May 26, 1982, the earliest scheduled date for reactor criticality is February 1990, and the total project cost estimate is \$3196.5 million, including research and development expenditures of \$818 million, 8% per year escalation during construction, substantial contingency allowances, and operating costs during the 5-year demonstration period. The latest date for completion of construction is stated to be January 1992.

11.1.7 Site Suitability (TN, A-25)

No changes have been made to this section.

11.1.8 Concentration of Water Impurities (TN, A-25)

The concentration factor has increased from approximately 2.5 to 2.7 because of changes in the cooling system requirements (see Section 3.3). This increase is environmentally insignificant.

11.2 The Site and Environs

11.2.1 Additional Baseline Information (BN, A-86 to A-91)

No changes have been made to this section.

11.2.2 Distance from CRBRP to Oak Ridge (OR, A-39, Item D.7)

No changes have been made to this section.

11.2.3 Jurisdictional Districts (OR, A-39, Item 8)

No changes have been made to this section.

11.2.4 General Site Description (BN, A-86)

No changes have been made to this section.

11.2.5 Population Within 5 Miles of the Site (OR, A-39, Item 9; ETDD, A-43)

No changes have been made to this section.

11.2.6 Relationship of Population to Agricultural Production (BN, A-86)

No changes have been made to this section.

11.2.7 Historic and Archeological Values (BN, A-86; HUD, A-9)

No changes have been made to this section.

11.2.8 Soils and Geologic Information (AG, A-2; NRDC, A-52)

No changes have been made to this section.

11.2.9 Karst Features (BN, A-86)

No changes have been made to this section.

11.2.10 Surface Water and Groundwater (BN, A-86)

No changes have been made to this section.

11.2.11 River Width (OR, A-39, Item D.11)

No changes have been made to this section.

11.2.12 Melton Hill Dam Releases and Milfoil (BN, A-86; TN, A-26; OR, A-39, Item D.12).

No changes have been made to this section.

11.2.13 1953 Tornado (BN, A-86; OR, A-40, Item D.14)

No changes have been made to this section.

11.2.14 χ/Q Values (OR, A-40, Item D.15)

The staff does not attempt to duplicate the χ/Q values which the applicants provide. Rather, the staff performs an independent analysis, as described in FES Section 6.1.3. In its updated analysis, the staff used meteorological data gathered between February 1977 and March 1978 and the values were slightly higher than those reported in the applicants' ER (Table 2.6-29). However, the changes are environmentally insignificant.

11.2.15 Frequency of Heavy Fog (OR, A-40, Item D.16)

No changes have been made to this section.

11.2.16 Unfavorable Meteorology (NRDC, A-52)

In the second paragraph, the second and third sentences have been replaced by the following:

However, nuclear power plant sites with similar or poorer dispersion factors have been deemed to be licensable. The atmospheric dispersion at the Clinch River site is comparable to that at other nuclear power plant sites in the northern Appalachian region of the country.

This change is not environmentally significant.

11.2.17 Air Quality (BN, A-86)

No changes have been made to this section.

11.2.18 Terrestrial Ecology (BN, A-87; TN, A-102; ERDA, A-13)

No changes have been made to this section.

11.2.19 Aquatic Ecology (BN, A-88, TN, A-30)

Section 2.7.2 has been updated. It is the staff's opinion that this section is sufficient for assessing aquatic biological impacts.

Table 2.5 has been updated. The four additional species of minnows (ER, Tables 2.7-87 and -88) taken by the applicants, as well as records from other investigations, have been included.

11.2.20 Social and Community Characteristics (BN, A-88)

No changes have been made to this section.

11.2.21 Mobile Homes in Oak Ridge (OR, A-40, Item 18)

The staff understands that Oak Ridge may adopt a change in ordinance to permit mobile homes within the city; however, there are no such mobile homes available at this time.

11.2.22 Overcrowding in Oak Ridge Schools (OR, A-40, Item 19)

No changes have been made to this section.

11.2.23 Personal Property Tax (OR, A-40, Item 20)

No changes have been made to this section.

11.2.24 Higher Costs for Low Income Citizens (ECNP, A-45, Item 1)

The first two paragraphs have been modified and combined as follows:

The construction of CRBRP could result in a large influx of people who would demand public and private services. In rural areas where the supply of services is limited, a rise in price could occur. In Section 6.1.6, the staff has recommended a monitoring program to determine actual impacts.

11.3 Facility Description

11.3.1 Public Use of the River (AR, A-5; DOI, A-11)

No changes have been made to this section.

11.3.2 Reactor and Steam-Electric System (ECNP, A-45, Item 2)

No changes have been made to this section.

11.3.3 Breeding (NRDC, A-53)

The applicants now project a breeding ratio of 1.29/1 with the initial core, and 1.24/1 with equilibrium cores (ER Table 3.3-2). This change from 1.2/1 in the FES is not significant to the staff's evaluation of environmental impacts of constructing the CRBRP.

11.3.4 Water Use at Maximum Power (TN, A-26)

Maximum water use would occur in the summer with a 7022 gpm makeup need, of which 4240 gpm would be consumed and 2782 gpm would be discharged to the river. These figures have increased only slightly over those in the FES; the changes are environmentally insignificant.

11.3.5 Design Parameters of Heat Dissipation System (PMC, A-95, Item 5)

Sections 3.3 and 3.4 have again been revised to reflect slightly lower cooling water requirements which have resulted from the project's choice of cooling towers. The changes are environmentally insignificant.

11.3.6 Intake and Discharge Locations (AR, A-6)

No changes have been made to this section.

11.3.7 Impingement Losses (TN, A-26)

The intake structure is subject to the requirements of Section 316(a) of the Clean Water Act.

Section 5.3.1.1 provides an updated assessment of the potential for impingement losses. Based on the design of the intake, its location, the biota inhabiting the river, and the preliminary results of studies conducted at similar intake structures, no significant losses due to impingement are expected. No reimbursement to the state for losses due to impingement and no degradation in water quality due to intake backwashing are anticipated.

This change in response provides further information and does not imply any change in the staff's previous assessment.

11.3.8 Use of Appendix I Criteria (EPA, A-17, 18; TN, A-25)

No changes have been made to this section.

11.3.9 NRC's Release Estimates More Conservative than ER (PMC, A-94, Item 3.F4)

No changes have been made to this section.

11.3.10 Liquid Radwaste Dilution Flow (TN, A-26)

No changes have been made to this section.

11.3.11 Filter or Evaporator Malfunctions (TN, A-26)

No changes have been made to this section.

11.3.12 Decay Time in Low-Activity System (PMC, A-95, Item 6)

No changes have been made to this section.

11.3.13 Chemicals in Low-Activity System (TN, A-26)

The suspended solids limitations and pH requirements in the draft NPDES Permit are now found on page I-6 of the permit (see Appendix H).

11.3.14 Barriers to Tritium Releases (EPA, A-18)

No changes have been made to this section.

11.3.15 Chemicals in Condensate-Feedwater System (TN, A-26)

No changes have been made to this section.

11.3.16 Activity in the Cooling Water Intake (TN, A-25)

No changes have been made to this section.

11.3.17 Bottling the Noble Gases (NRDC, A-53, 54)

No changes have been made to this section.

11.3.18 Effluent From Cell Air Processing System (ERDA, A-13)

The effluent release rate from the CAPS will range from 0 to 64 scfm, rather than 0 to 125 scfm.

11.3.19 Radwaste Treatment Similarities to Other Reactor Types (DH, A-101)

No changes have been made to this section.

11.3.20 Disposition of Sodium-Bearing Wastes (EPA, A-17, 18)

The first paragraph has been revised to read as follows:

In updated Section 3.5.3 of this document, the staff estimates that approximately 750 ft³ of sodium-bearing waste containing 1.6×10^4 Ci of activity would be generated annually, and it would be stored onsite since no currently licensed offsite disposal facility will accept sodium-bearing waste. This is a change from the FES, in which shipment offsite of about one-third that quantity of waste, but with somewhat greater total activity, was contemplated.

This change is not significant environmentally because either method of disposal would have to meet NRC limitations.

11.3.21 Contradiction on Page 3-18 (TN, A-25)

No changes have been made to this section.

11.3.22 Sodium Nitrate Waste (TN, A-26)

No changes have been made to this section.

11.3.23 Radioactive Waste Shipments (TN, A-25)

Because no burial sites presently will accept radioactive sodium, the applicants now state that elemental sodium will be stored or processed to a disposable form in a to-be-determined manner (amended ER pages 3.5-18 and -19). This is a change from shipment off site, as discussed in the FES, but it is not environmentally significant because either method must meet NRC limitations.

11.3.24 Radwaste Disposal Site (EPA, A-17; TN, A-25, 26, 27)

The third and fifth paragraphs of this response have been modified as follows:

The staff has estimated the environmental impact associated with all waste management operations, including a Federal repository. These impacts are now shown in Table D-4 of Appendix D.

Table 4.18 of the task force report (NUREG-0116) indicates negligible doses to the population resulting from operation of a waste repository. As discussed in Appendix D, the nature of the waste from fast reactor fuel is not sufficiently different to change this result, and, therefore, the staff concludes that the environmental impact of short-term operation of the waste repository facilities is negligible.

The above changes simply point out where the updated information is currently in Appendix D.

11.3.25 Description of Licensed Burial Site (AR, A-6)

The second paragraph has been updated to read as follows:

Specific criteria for an acceptable burial site are developed under 10 CFR 61. A description of the reference disposal facility is provided in the draft EIS which supports 10 CFR 61 (NUREG-0782). An adequate land burial facility consists of an area that is sparsely settled, with access to highway transportation. Groundwater level should be well below the deepest trench. The site hydrology should provide for minimal flooding of trenches and leaching of buried radioactive material, and the soil should provide for good ion exchange. Site selection should require no nearby use of groundwater or well water downstream of the site.

The sixth paragraph has been changed to read as follows:

After burial operations cease, the disposal facility will be subject to an institutional control period to restrict access to the site. Individual states and/or the Federal government are responsible for perpetual care and maintenance and for ensuring restriction from other uses.

The above changes are primarily to direct the reader to current regulations and do not represent a significant change environmentally.

11.3.26 Health Consequences from Delayed Releases from Licensed Burial Sites (NRDC, A-54)

The response in the FES has been replaced by the following:

A comment on Section 3.5.3 was that the staff should analyze the health consequences of "delayed releases" of solid radioactive waste from burial grounds. The performance objectives in proposed 10 CFR 61 for a low level waste disposal facility would require that the facility be sited, designed, operated, and closed in a manner to preclude off-site doses in excess of 25 mrem per year. The long-term radiological impacts for a low level burial site have been assessed in NUREG-0782.

The above response simply directs the reader to the reference which contains the information desired and does not represent a change in expected impacts of the CRBRP.

11.3.27 Chemicals in Plant Discharge (TN, A-27)

No changes have been made to this section, except to note that Table 3.5 has been replaced by Table A3.2.

11.3.28 Corrosion Inhibitors, New Source (ERDA, A-13; EPA, A-22, Item 3)

No changes have been made to this section.

11.3.29 Hypochlorite Use at Intake (OR, A-40, Item 21)

The NPDES chlorine requirements are now found on page I-17 (see Appendix H).

11.3.30 Oil and Grease Discharge (TN, A-27)

No changes have been made to this section.

11.3.31 Wastewater Characteristics (TN, A-27)

No changes have been made to this section.

11.3.32 Use of Polychlorinated Biphenyls (TN, A-27)

Special conditions governing the use of PCBs are now found in item III.B of the revised draft NPDES Permit (see Appendix H).

11.3.33 Storm Drainage (TN, A-27)

The response has been replaced with the following:

In accordance with the draft NPDES Permit, item III.J., the applicants must have an approved Erosion and Sediment Control Plan prior to the start of construction.

This new requirement by EPA is not expected to result in significant differences in environmental impacts attributable to plant construction and operation.

11.3.34 Off-Site Disposal of Non-Radioactive Waste (OR, A-40, Item 22; TN, A-27)

No changes have been made to this section.

11.3.35 Sanitary Waste (TN, A-27)

The plan to include sand filtration has been dropped.

11.3.36 Residual Chlorine in Sanitary Waste Effluent (ERDA, A-13)

No changes have been made to this section.

11.4 Environmental Impacts Due to Construction

11.4.1 LWA and NEPA Procedures (AR, A-5)

The Corps of Engineers has issued the permits needed by the applicants prior to construction of facilities at or in the river for the CRBRP.

11.4.2 Construction Employment (OR, A-40, Item 24; PMC, A-93, Item 3.B.1)

No changes have been made to this section.

11.4.3 Secondary Employment (PMC, A-93, Item 3.B.2)

No changes have been made to this section.

11.4.4 Exxon Nuclear Fuel Plant (OR, A-40, Item 23; PMC, A-93, Item 3.B.3)

The Exxon project has been cancelled.

11.4.5 Erosion Control (AG, A-2)

No changes have been made to this section.

11.4.6 Revegetation of Transmission Line Corridor (DOI, A-11)

No changes have been made to this section.

11.4.7 Terrestrial Impacts (BN, A-89)

No changes have been made to this section.

11.4.8 Barge Traffic (AR, A-3)

No changes have been made to this section.

11.4.9 Materials Barged (AR, A-3)

No changes have been made to this section.

11.4.10 Disposal of Dredged Material (ERDA, A-13; TN, A-27; PMC, A-96, Item 16)

The amount of dredged material estimated for disposal has been further reduced from 20,000 m³ to 8,500 m³ as a result of the redesign of the barge-unloading facility. This is an environmental benefit but does not represent a significant environmental change since the impact of dredging was already considered to be of minor consequence (see Section 4.4.2).

11.4.11 TDWQC Certification (TN, A-27)

The Tennessee Division of Water Quality Control has stated its conditions for certification of the NPDES Permit (see Appendix H, Attachment D).

No significant change in the staff's assessment of impacts is expected.

11.4.12 Minimizing Socioeconomic Impacts (HEW, A-8, HUD, A-9)

No change is needed in this section of the FES. However, the staff assessments in Sections 4.5 and 5.6 have been revised.

11.4.13 School Impacts (PMC, A-93, Item 3.C)

The second paragraph of the response in the FES has been deleted.

11.4.14 Impact on Housing (HUD, A-9; RC, A-33, Item 4)

In ER Amendment X (1982), the applicants indicate that approximately 30% of the workers are expected to locate in mobile homes (ER, Appendix to Chapter 8, Tables 2.1-2 and 2.1-6).

11.4.15 Water, Wastewater, and Solid Waste Impacts on Communities (TN, A-27)

No changes have been made to this section.

11.4.16 General Impacts on Roane County (RC, A-31, 32)

No changes have been made to this section.

11.4.17 Traffic Congestion (TN, A-29; RC, A-32, Item 1; OR, A-36, Item A.1)

No changes have been made to this section.

11.4.18 Sanitary Sewage Discharges (RC, A-32, Item 2)

No changes have been made to this section.

11.4.19 Solid Waste Disposal (RC, A-32, Item 3)

No changes have been made to this section.

11.4.20 Local Planner (RC, A-33, Item 5)

No changes have been made to this section.

11.4.21 Assessment of Socioeconomic Impact (RC, A-33, Item 6)

The word "significant" has been removed from the first sentence, which now reads as follows:

The staff assessment of socioeconomic impacts resulting from CRBRP indicated that impacts could occur within the local rural counties.

This change indicates that the staff now believes that such impacts will not be as large as previously forecast (see revised Section 4.5).

11.4.22 Tax Revenues (RC, A-34, Item 7; OR, A-36, Item A.2)

The staff has now concluded that the portion of increased state sales tax, gas tax, cigarette taxes, and liquor taxes that would be returned to the communities

as a result of the project would generally be equal to increased expenditures for public services. (See the revised evaluations in Chapters 4 and 5 of this document.)

11.4.23 Miscellaneous Roane County Questions (RC, A-34, Item 8)

Changes have been made in responses g, h, and j as shown below:

- g. PMC, TVA and DOE are co-applicants. The NRC construction permit would be issued to them jointly.
- h. DOE is the proper entity with which to discuss mitigation of CRBRP impacts.
- j. The magnitude of the increased county services required, as suggested by Roane County, has been estimated by the applicants (ER Am X), but should become further quantified as a result of monitoring by the applicants (see Section 6.1.6).

The above changes are environmentally insignificant.

11.4.24 Mitigation of Impacts on Oak Ridge (OR, A-37, Item A.3)

No changes have been made to this section.

11.4.25 Combined Construction Effects (OR, A-37, Item A.4)

No changes have been made to this section.

11.4.26 Costs to Local Businessmen (OR, A-37, Item A.5)

In the first paragraph the second sentence has been replaced by the following:

Short-term costs may accrue to local businessmen who are forced to replace existing workers who leave in order to work on the CRBRP.

The above changes is not a significant change in predicted impacts.

11.4.27 Source of Work Force During Plant Operation (ETDD, A-43)

It is quite probable that a percentage of the support personnel will be recruited from the unemployed, the underemployed, and spouses of technical workers. This statement more directly addresses the comment but does not indicate a significant change of impact.

11.4.28 Morgan County Impacts (ETDD, A-43)

No changes have been made to this section.

11.4.29 Local Government Costs for Services (ETDD, A-103)

No changes have been made to this section.

11.4.30 In-Lieu-of-Tax Payment Applications (ETDD, A-103; AC, A-30)

No changes have been made to this section.

11.4.31 Local Government Services for Mobile Homes (ETDD, A-104)

No changes have been made to this section.

11.4.32 Availability of Socioeconomic Impact Data (ETDD, A-104)

No changes have been made to this section.

11.4.33 Impacts on Lake City (ETDD, A-105)

No changes have been made to this section.

11.4.34 Health Services (ETDD, A-106)

No changes have been made to this section.

11.4.35 Property Taxes During Construction (PMC, A-93, Item 3.D)

No changes have been made to this section.

11.4.36 Plant Appearance (OR, A-40, Item 25)

No changes have been made to this section.

11.5 Environmental Impacts of Plant Operation

11.5.1 Switchyard 60-cycle Hum (OR, A-40, Item 26)

No changes have been made to this section.

11.5.2 Melton Hill Dam (AR, A-6; PMC, A-92, Item 1; TN, A-28)

No changes have been made to this section.

11.5.3 Closure of the Waterway (AR, A-3)

No changes have been made to this section.

11.5.4 Downstream Water Use (ERDA, A-13; TN, A-28)

No changes have been made to this section.

11.5.5 Classified Uses of the River (TN, A-28)

No changes have been made to this section.

11.5.6 Sport Fishing Activity (OR, A-4, Item 29)

No changes have been made to this section.

11.5.7 Cumulative Effects of Discharges (DOI, A-11)

No changes have been made to this section.

11.5.8 Impingement Losses (OR, A-4, Item 30)

The intake velocity has been reduced from a range of 0.3 to 0.5 fps to 0.2 to 0.4 fps. This is an insignificant change.

11.5.9 Compliance with FWPCA (EPA, A-17, Item 4 and A-21)

The following has been added to the response:

The draft NPDES Permit specifies conditions for compliance with the Clean Water Act (formerly referred to as the FWPCA). See Appendix H of this document. While this current version of the permit is more restrictive than the previous one, no significant difference in environmental impacts is expected.

11.5.10 Impacts of Cooling Water Discharge (MPC, A-92, Item 2)

No changes have been made to this section.

11.5.11 Cooling Tower Drift Rate (OR, A-41, Item 32)

No changes have been made to this section.

11.5.12 Interaction With Atmospheric Plume from ORGDP (OR, A-41, Item 33)

No changes have been made to this section.

11.5.13 Fog on Route 95 and Bear Creek Road (OR, A-41, Item 34)

No changes have been made to this section.

11.5.14 Chlorine in the Cooling Tower Drift (OR, A-40, Item 27)

No changes have been made to this section.

11.5.15 Long-Term Drift Deposition (OR, A-40, Item 28)

No changes have been made to this section.

11.5.16 Drift Effects on Cave-Related Species (BN, A-89)

No changes have been made to this section.

11.5.17 Downstream Chemical Concentrations (PMC, A-95, Item 8)

No changes have been made to this section.

11.5.18 Disposal of Nonradioactive Waste (TN, A-26, 28)

No changes have been made to this section.

11.5.19 Medical Facilities (HEW, A-8)

No changes have been made to this section.

11.5.20 Required Community Services (PMC, A-93, Item 3.E.1)

No changes have been made to this section.

11.5.21 Population Increase During Plant Operation (PMC, A-93, Item 3.E.2)

The staff analysis of the population increase during plant operation has been revised as shown in Section 5.6 of this document. The Centar and Exxon projects contemplated for the area when the FES was being prepared have not materialized and further construction of the Phipps Bend Nuclear Plant has been deferred.

11.5.22 Personal Property Taxes During Operation (PMC, A-93, Item 3.F.1)

No changes have been made to this section.

11.5.23 In-lieu-of-Tax Payments by TVA (PMC, A-93, Item 3.F.2)

No changes have been made to this section.

11.5.24 Reference to Radiation Pathway Model in Section 5.7 (AC, A-31)

The current version of Regulatory Guide 1.109 is dated October 1977.

11.5.25 Radiological Impact on Biota Other Than Man (NRDC, A-54)

No changes have been made to this section.

11.5.26 Concentration of Radioactive Elements in Wildlife (DOI, A-11)

No changes have been made to this section.

11.5.27 Bioaccumulation Factor in Table 5.10 (ERDA, A-13)

No changes have been made to this section.

11.5.28 Dispersion of Gaseous Releases (C, A-8)

No changes have been made to this section.

11.5.29 Dose to Most Critical Individual (EPA, A-22, Item 2)

No changes have been made to this section.

11.5.30 Occupational Radiation Exposure (NRDC, A-55)

No changes have been made to this section.

11.5.31 Radioactive Waste Transport Route (NC, A-24)

No changes have been made to this section.

11.5.32 Summary of Annual Radiation Doses (EPA, A-18; NRDC, A-55)

The response given in the FES to NRDC comment item 3 on page A-55 has been modified as follows:

- (3) Although calculation of health effects from very low level population doses is subject to great uncertainties, the staff has estimated potential health effects in updated Sections 5.7.2.5 and 5.7.3 of this document.

As indicated above, the staff is now providing the calculated health effects information requested. However, these effects are very small and do not represent a significant change in predicted impacts.

11.6 Environmental Measurement and Monitoring Programs

11.6.1 Radionuclide Analyses (ERDA, A-13)

No changes have been made to this section.

11.6.2 Radiological Monitoring of Filter Feeders (C, A-7)

Table 6.2 in the DES became Table 6.1 in the FES. No change has been made in the response to the comment.

11.6.3 Surface Water Radiological Monitoring (DOI, A-10)

No changes have been made to this section.

11.6.4 Environmental Monitoring for Tritium (EPA, A-20)

No changes have been made to this section.

11.6.5 Preoperational Radiological Monitoring (TN, A-25)

No changes have been made to this section.

11.6.6 Health Survey (ECNP, A-45, Item 3)

No changes have been made to this section.

11.6.7 Enforcement of Applicants' Monitoring Programs (NRDC, A-55)

No changes have been made to this section.

11.6.8 Modifications to Meteorological Tower (PMC, A-97, Item 22)

Section 6.1.3 has again been revised to include new data supplied by the applicants in ER Am XI. These data are cumulative and do not significantly change the basis for the staff's environmental assessments.

11.6.9 Commercial Fisheries (C, A-7)

The response in the FES has been replaced as follows:

The draft NPDES Permit, Sections III.N and O, requires the applicants to have approved preoperational and operational nonradiological aquatic monitoring programs. The details of these programs are to be developed after construction is under way (see Appendix H of this document). The staff's opinion is that adequate information would thus become available for detecting CRBRP-caused changes in commercial fisheries and assessing their significance.

The above changes inform the reader that EPA rather than NRC is now responsible for specifying the aquatic monitoring requirements; this is not environmentally significant.

11.6.10 Heavy Metals in Biota and Sediments (C, A-7)

The following has been added: "Such monitoring should be considered for inclusion in the nonradiological aquatic monitoring programs required by the NPDES Permit."

The above addition to the previous staff response is intended to clarify the fact that the EPA, rather than NRC, is responsible for specifying what aquatic monitoring is required.

11.6.11 Groundwater Monitoring (DOI, A-10)

No changes have been made to this section.

11.7 Environmental Impacts of Postulated Accidents

Plant Accidents

11.7.1 Acceptability of Reactor Accident Risk (EPA, A-15, -20; DOI, A-10; TN, A-25; CC, A-44, 45)

In the fourth paragraph, the guideline doses to "other organs" have been revised, so that the third sentence now reads as follows:

The exclusion area is of such size that an individual located at any point on its boundary for 2 hours immediately following onset of the postulated fission product release would not receive a total radiation dose in excess of 25 rems to the whole body or 300 rems to the thyroid, or equivalent doses to other organs (75 rems to the lung and 300 rems to bone surfaces). An additional guideline coupled to the guidance on doses to specific organs is that the mortality risk equivalent whole body dose from any postulated design-basis accident (on a calculated dose basis) for the CRBRP should be no greater than the mortality risk equivalent whole body dose value of 10 CFR 100 for a light water reactor (i.e., 34 rems whole body risk equivalent). The dose guidance of 10 CFR 100 was primarily developed for light water reactors; for the CRBRP, because it is a liquid metal fast breeder

reactor (LMFBR), dose guidelines are provided for the lung and bone surfaces which are equivalent to the 10 CFR 100 dose guideline for the thyroid dose. These dose guidelines will be used in the preparation for the CRBRP operating license; during preparation for the construction permit, however, smaller guideline values are used to allow for greater uncertainties in plant- and site-specific data (see Section 11.7.5).

The above guideline values also apply to the low population zone discussed in the fifth paragraph.

The change in guideline dose to bone is intended to better specify what is intended. No significant difference is expected in terms of environmental impact.

11.7.2 Comparability of Accident Risks to LWRs (HEW, A-8; EPA, A-19; TN, A-26; ECNP, A-46)

No changes have been made to this section.

11.7.3 The Feasibility of Accident Assessment at This Time (DOI, A-10; EPA, A-17, 20; TN, A-30; NRDC, A-49, 56, 57)

No changes have been made to this section.

11.7.4 Adequacy of Criteria and Standards (AR, A-5; EPA, A-17, 20; ECNP, A-46)

In the fourth paragraph, the fourth sentence has been modified to read as follows:

10 CFR 100 can be applied to LMFBRs (it has been so used previously) provided that due allowance is made for the risks of doses to other organs than the thyroid, and the limited experience with this type of plant.

11.7.5 Plutonium Dose Guidelines (ERDA, A-14; EPA, A-20; TN, A-30; OR, A-39; CC, A-44; NRDC, A-57)

The second sentence of the fourth paragraph has been changed to read:

The staff's dose conversion factors are based on International Commission on Radiological Protection (ICRP) Publication II.

The fifth paragraph of this section has been corrected to read as follows:

The staff specified in its May 6, 1976 letter to the applicants that plutonium dose values 1/10th of those identified in the DES (Table 7.2, footnote 5) were to be used at the construction permit stage of review (see Appendix I). To bring the dose guidelines into conformance with more recent authoritative scientific consensus on the health risks of radiation exposure, the staff has since modified the additional dose guidelines to be applied for the CRBRP operating license review as given in Section 11.7.1. For the construction permit review, the

dose guidelines have also been updated from the 1977 FES, considering both recent scientific opinion and more recent data on the CRBRP plant and site, and now are specified as 150 rems to the thyroid, 20 rems whole body, 35 rems to the lung, and 150 rems to bone surfaces, with a mortality-risk-equivalent whole-body-dose value of 24.5 rems. The equivalency of the additional organ dose guidelines to the 10 CFR 100 thyroid guideline value and the mortality risk equivalent whole body dose guideline value were determined using the stochastic weighting factors in ICRP Publication 26.

The modified guideline values above are not expected to be environmentally significant in terms of doses or health effects.

11.7.6 Design Details Affecting Accident Analysis (ECNP, A-46; PMC, A-97; DH, A-101)

No changes have been made to this section.

11.7.7 Quality Assurance (ECNP, A-46)

No changes have been made to this section.

11.7.8 Table 7.1 (PMC, A-97, Item 23A)

No changes have been made to this section.

11.7.9 Table 7.2 (PMC, A-97, Item 23B)

No changes have been made to this section.

11.7.10 Accidental Releases of Stored Noble Gases (EPA, A-20)

In considering a postulated storage tank rupture, it was judged that the event analyzed as 3.2 (rather than 3.3) in Table 7.2 is of greater significance and was a more representative event of this category.

11.7.11 Table 7.3 (PMC, A-97, Item 23C)

No changes have been made to this section.

11.7.12 Seismic Considerations (NRDC, A-52)

The third and fourth sentences of the response have been replaced by the following:

It has been proposed that an earthquake of intensity MM VIII, characterized by a horizontal ground acceleration of 0.25 g, anchoring a Regulatory Guide 1.60 spectrum, is appropriate for CRBRP structural design. The appropriateness of this earthquake characterization is under review and will be discussed in the staff's Safety Evaluation Report. Plant features required to maintain containment and essential heat sinks will be required to be designed to withstand the appropriate earthquake without serious risk to the public or to the environment.

11.7.13 Sodium Behavior (CC, A-44)

No changes have been made to this section.

11.7.14 Self-Activated Shutdown Systems (EPA, A-19, 20)

No changes have been made to this section.

11.7.15 Flooding (DOI, A-10)

No changes have been made to this section.

11.7.16 Emergency Preparedness Plans (OR, A-38; CC, A-45)

The fifth sentence of the first paragraph has been replaced by the following:

In addition, the Commission has issued NUREG-0654/FEMA-REP-1, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants," Revision 1, November 1980, for the purpose of providing detailed guidance to applicants and state and local agencies for the preparation of plans to cope with emergencies. NUREG-0654 has been endorsed by Regulatory Guide 1.101 (Revision 2).

In the second paragraph, NUREG-0654 has been substituted for Regulatory Guide 1.101.

The third paragraph has been replaced by the following:

Because facility operators may require assistance in dealing with emergencies, their planning normally includes arrangements with off-site organizations for such services as ambulance, medical, hospital, fire, and police. Further, the facility operator is required to coordinate the onsite emergency plan with the emergency response plans of state and local authorities. As provided in a Presidential Directive dated December 7, 1979, the Federal Emergency Management Agency (FEMA) is responsible for the review and evaluation of state and local radiological emergency response plans and preparedness for areas around nuclear power plants.

In the fourth paragraph, the last sentence has been modified to read:

Consistent with the above, the NRC staff in its safety review of an applicant's plans for coping with emergencies--and in its review of FEMA's findings and determinations as to whether state and local emergency plans are adequate and capable of being implemented--must be able to conclude that there is a reasonable assurance that protective measures can and will be taken both onsite and offsite in behalf of the public health and safety.

The above changes provide updated information, but they are not environmentally significant.

11.7.17 Insurance Liability (OR, A-38; CC, A-45, Item E)

In the first paragraph of the FES response, the words "currently \$125 million" have been deleted and the following sentences inserted:

That insurance, presently \$545 million, is comprised of primary private nuclear liability insurance of \$160 million available from two nuclear liability insurance pools, American Nuclear Insurers (ANI) and Mutual Atomic Energy Liability Underwriters (MAELU), and a secondary retrospective premium insurance layer up to \$5 million per reactor per incident but not in excess of \$10 million for a single reactor in any year. With 77 commercial reactors operating under the system, the secondary layer totals \$385 million. As a licensed facility, the CRBRP would be assessed this premium in the event of a nuclear incident resulting in damages exceeding the amount of the current \$160 million primary insurance layer.

The second paragraph has been deleted.

In the third paragraph, the following has been inserted after the first two sentences:

The present government indemnity level is \$15 million, the difference between the financial protection layer of \$545 million and the \$560 million liability limit.

The last sentence of the fourth paragraph and paragraphs five and six have been deleted.

The above changes provide updated information which is not significant to the staff's environmental assessment.

11.7.18 Packages of Radioactive Materials Shipped (OR, A-41, Item 35a)

NUREG-0034 has been superseded by NUREG-0170, the final environmental statement on the "Transportation of Radioactive Material by Air and Other Modes," December 1977.

11.7.19 Category 5 Shipping Accidents (OR, A-41, Item 35b)

No changes have been made to this section.

11.7.20 Spent-Fuel Shipment (OR, A-41, Item 35d)

No changes have been made to this section.

11.7.21 Beta-Gamma Waste Shipment (OR, A-41, Item 35e)

The reference to Table 5 has changed to Table D.15 of this document.

11.7.22 Doses from a Postulated Transportation Accident (OR, A-41, Item 35f)

The following sentence has been inserted after the second sentence in this section:

Doses for children would generally be higher than doses for adults at 3 meters as well as at 50 meters for most nuclides of concern.

The above insert is not environmentally new or significant information.

11.7.23 Table 7.4 - Doses from Category 5 Accidents (OR, A-41, Item 35g; ERDA, A-14)

No changes have been made to this section.

11.7.24 Risk in Shipping Fresh Fuel (OR, A-41, Item 35h)

No changes have been made to this section.

11.7.25 Safeguards Approach (EPA, A-17, Item 2(2))

The safeguards portions of the 1977 CRBRP Final Environmental Statement, principally Appendix E, have been updated and substantially revised. However, the changes do not result in significantly different impacts than those predicted in the FES. In the updated version the staff's assessment does not rely heavily on the assumption that new safeguards technologies will be developed.

Safeguards Considerations

11.7.26, 11.7.27, 11.7.28 Safeguards Considerations (NRDC, A-59)

In the years since these comments were received (early 1976) several of the issues raised have been addressed by the NRC. The NRC safeguards objective was specified in the following Commission statement, issued in May 1976:

Safeguards measures are designed to deter, prevent, or respond to (1) the unauthorized possession or use of significant quantities of nuclear materials through theft or diversion; and (2) sabotage of nuclear facilities. The safeguards program has as its objective achieving a level of protection against such acts to insure against significant increase in the overall risk of death, injury, or property damage to the public from other causes beyond the control of the individual.

The nature of the safeguards threat to nuclear facilities has been studied extensively by the NRC and conclusions have been published in NUREG-0703, "Potential Threat to Licensed Nuclear Activities from Insiders (Insider Study)," July 1980, and in NUREG-0414, "Safeguarding a Domestic Mixed Oxide Industry Against a Hypothetical Subnational Adversary," May 1978. In addition, the current version of the physical security regulations in 10 CFR 73 contains a specification of the threat that must be used by NRC licensees as a design basis (10 CFR 73.1). Economic costs of safeguards and societal impacts were also discussed in NUREG-0414. This report concluded that the safeguards measures required to protect a mixed oxide (MOX) industry are not likely to have severe societal effects or to cost more than the safeguards required for the non-MOX nuclear industry.

The NRDC comment of about 7 years ago includes the statement that existing NRC safeguards regulations are inadequate. Since that time, upgraded physical

security requirements for nuclear power reactors (10 CFR 73.55) and facilities possessing formula quantities of special nuclear material (10 CFR 73.45 and 73.46) have been put into effect. The staff believes that the CRBRP can be adequately safeguarded under the current regulations. It should be noted that the conversion, fuel fabrication, reprocessing facilities, and transportation activities related to the CRBRP will be carried out under DOE regulations. The staff has performed a general assessment of the applicants' proposed safeguards systems for licensed and unlicensed CRBRP fuel cycle activities and has concluded that the probability of a successful theft, diversion, or sabotage is low and, therefore, the risks associated with the events do not represent a significant increase over the risks associated with currently operating facilities. This assessment is in Appendix E.

Although NRC requirements have become more formalized in recent years, no significantly different impacts from safeguards are now anticipated.

11.8 Need for the Proposed Facility

11.8.1 Objectives of the CRBRP (ECNP, A-46, Item 9)

No changes have been made to this section.

11.8.2 Progress Since Fermi (ECNP, A-46, Item 10)

No changes have been made to this section.

11.8.3 Need for the CRBRP (NRDC, A-59, 60)

No changes have been made to this section.

11.9 Alternatives

11.9.1 Alternative Energy Sources (EP, A-91; GEI, A-47; NRDC, A-60, 61)

The first sentence of the response has been replaced with the following:

The principal purpose of the CRBRP is to demonstrate the LMFBR concept in a utility environment rather than to meet electricity requirements; consequently, this statement considers only alternatives permitting attainment of that objective.

This change is not environmentally significant.

11.9.2 Alternatives to the CRBRP (NRDC, A-60, 61)

No changes have been made to this section.

11.9.3 Sites With More Favorable χ/Q Values (NRDC, A-61)

No changes have been made to this section.

11.9.4 Sites at Hanford, Idaho, and Nevada (NRDC, A-61)

No changes have been made to this section.

11.9.5 Co-Location with Fuel Cycle Facilities (EPA, A-20, 21; NRDC, A-61)

No changes have been made to this section.

11.9.6 Underground Sites (NRDC, A-61)

The last paragraph of the response has been replaced by the following:

Early in 1975 a study was initiated by the NRC to obtain authoritative answers to generic questions associated with the underground siting concept. This research resulted in publication of a report (NUREG-0255) entitled "Underground Siting of Nuclear Power Plants: Potential Benefits and Penalties," which was published in August 1977. The study examined the potential benefits to safety as well as any potential penalties that might result from siting plants underground in mined cavities or by covering plants with fill earth after construction in an excavated cut.

The study concluded that underground plants had safety advantages over surface plants with regard to

- (1) protection against aircraft crashes or warfare munitions which could conceivably initiate a reactor accident, and
- (2) improved retention of radioactive releases to the atmosphere following a core meltdown, provided that the numerous penetrations to the surface from an underground plant were promptly isolated and maintained closed during and subsequent to an accident to prevent release of radioactivity to the atmosphere. The study identified the design and appropriate maintenance of such seals as a critical design problem for underground plants, and also pointed out that prompt isolation of such seals could reduce the movement of any operating or maintenance personnel located below ground at the time of an accident.

The study also found that there may be a modest reduction in seismic vulnerability for underground plants.

The principal disadvantages of underground plants were found to be

- (1) greater operational problems associated with inservice inspection and maintenance which, in turn, could lead to decreased equipment reliability and an increased probability of an accident,
- (2) groundwater contamination, which was more likely in an underground plant following an accident, and
- (3) the increased cost for an underground plant, which was estimated to be 20 to 40% greater than that for a surface plant.

The overall conclusion of the study was that the expected benefits of underground siting in terms of improved safety do not appear to offset the penalties.

The above information is cumulative and does not significantly change the staff's conclusions on this matter in the FES.

11.9.7 Cooling Tower Arrangement (PMC, A-97, Item 24)

No changes have been made to this section.

11.9.8 Corrections in Table 9.5 (ERDA, A-14)

The comment referred to Table 9.5 of the DES, which became Table 9.8 in the FES. There has been no change in the response.

11.9.9 Thermal Effects at the Discharge (OR, A-41, Item 31)

The following has been added to the response:

Conditions for protection of the aquatic environment from thermal impacts are specified in the draft NPDES Permit (see Appendix H of this document).

11.9.10 Ease of Monitoring (TN, A-26)

No changes have been made to this section.

11.9.11 Proximity to the Gaseous Diffusion Plant and ORNL (NRDC, A-62)

The first paragraph of the FES response has been replaced with the following:

The Oak Ridge Gaseous Diffusion Plant, which produces enriched uranium, is about 3 miles north-northwest from the Clinch River site. Oak Ridge National Laboratory, located about 4 miles east-northeast from the site, is engaged in basic and applied research for nuclear and other energy-related technologies. Production, research, and development for DOE's national defense programs are provided by the facilities at the Y-12 plant located about 9 miles northeast of the proposed CRBRP site. These facilities at the Oak Ridge reservation are under the control of DOE; long range land-use planning and selection of sites for future activities are governed by official DOE procedures and instructions.

In the second paragraph, the last sentence has been replaced with the following:

There are existing DOE plans and facilities for coping with plant emergencies, such as a release of toxic material. However, it must also be recognized that due to the nature of operations at the gaseous diffusion plant and other Oak Ridge facilities, information is not readily available. Consequently, the staff has not evaluated the impacts of severe accidents on activities at the DOE-controlled facilities.

The above changes are not environmentally significant.

11.10 Evaluation of the Proposed Action

11.10.1 Risks Associated with Accidental Radiation Exposure (NRDC, A-62)

No changes have been made to this section.

11.10.2 Health Consequences (NRDC, A-62)

The second sentence of the response has been changed to read:

Potential health effects are estimated in updated
Sections 5.7.2 5 and 5.7.3.

11.10.3 Alternative Development of Site (OR, A-38, Item B)

No changes have been made to this section.

11.10.4 Complementary Uses of Site (OR, A-38, Item B)

No changes have been made to this section.

11.10.5 Public Uses of "Restricted Area" (OR, A-38, Item 3B)

No changes have been made to this section.

11.10.6 Decommissioning (NRDC, A-63)

The response to the first comment has been replaced by the following:

An isolation period has not been estimated for any decommissioned licensed reactor but has been estimated for Piqua, Hallam, and Bonus (Demonstration power plants), which were entombed. The radionuclide Ni-63 (92-year half life) was analyzed in determining the acceptability of the entombment structures. In the Piqua decommissioning report (AI/AEC 12832, 1970) the Ni-59 inventory was determined to be about 1% of the Ni-63 inventory. NUREG/CR-0130 predicts about the same ratio of Ni-59 to Ni-63 for PWR reactors. Isolation periods for Piqua, Hallam, and Bonus were estimated at 100 to 140 years. For these periods of time, the inventory of NI-63 would be expected to exceed the inventory of Ni-59 by a factor of 30 to 50.

The response to the second comment has been replaced as follows:

The NRC staff position is that long-lived isotopes (Nb-94, NI-63, and Ni-59) in excess of quantities acceptable for release to unrestricted access areas would be removed at the end of a mothball/safe storage period or removed before entombment. Therefore, there is no need to consider an isolation period of 1.5 million years.

The response to the third comment has been replaced as follows:

Section 10.2.4.1 of this document addresses the environmental impacts of decommissioning the CRBRP more completely than does the 1977 FES. The NRC anticipates that the plant will either be dismantled shortly after final shutdown or dismantled after a period of 50 to 100 years in a safe storage status. For these alternatives, there is no isolation period following decommissioning, because decommissioning is not complete and the license is not terminated until residual radioactivity, above levels acceptable for release to unrestricted access areas, is removed from the site. If the CRBRP is entombed, components with long-lived radionuclides, such as the reactor vessel internals and the reactor vessel itself, would have to be removed prior to entombment. For this alternative also, decommissioning would not be complete and the license would not be terminated until residual radioactivity meets the current criteria for release of the facility to unrestricted access areas.

The staff presently relies on estimates of neutron activation products in NUREG/CR-0130 and data from previously decommissioned reactors. In addition, the NRC has contracted with Battelle/PNL to review the applicants' estimates of neutron activation products important to decommissioning.

The above information has been updated to provide information available at this time. No significant changes in the impacts assessed in the FES are anticipated.

11.10.7 Achieving CRBRP Objectives (NRDC, A-63)

No changes have been made to this section.

11.10.8 Payroll 1991-2013 (EP, A-91)

The response in the FES has been updated as follows:

The CRBRP payroll is estimated in amended ER Section 8.2.2.1 to be a total of \$613,300,000 during construction and the 30-year operation of the plant.

The increased payroll constitutes a substantial benefit to the local area, but it does not significantly change the staff's evaluation of the CRBRP.

11.10.9 Cost Estimates (EP, A-91)

The response in the FES has been replaced as follows:

The applicants' revised cost estimate for the CRBRP to a project total of \$3196.5 million and the staff's analysis are given in Section 10.4.2.2. Capital cost information for commercial LMFBR reactors is provided in WASH-1535, Section 11, and ERDA-1535, Section III F.2, but it has not been updated.

The above change in cost is not significant to the staff's environmental review since the Congress and the President determine whether the project is worth its cost.

11.10.10 Benefit Cost Balance (EP, A-91)

The second paragraph in this section has been replaced with the following:

The staff's overall cost-benefit conclusion is that the Clinch River project, as currently defined, offers the "least cost" solution for meeting the programmatic objectives under the LMFB program (Section 10.4.3).

11.11 Appendix D - Environmental Effects of the CRBRP Fuel Cycle and Transportation of Radioactive Materials

11.11.1 and 11.11.2 Doses from Fuel Cycle Effluents (ERDA, A-14)

The staff has reassessed the doses from normal CRBRP fuel cycle operations in light of DOE's latest information as contained in ER Am XIV. These assessments are summarized in Table D.17 of Appendix D to this document. Although the estimated doses to the U.S. population are somewhat higher than previously projected, they are still a small fraction (0.001%) of the corresponding population dose from 1 year of exposure to natural background radiation.

The above changes are insignificant in terms of environmental effects.

11.11.3 Basis for Estimates Used in Tables of Appendix D (NRDC, A-63, 64)

The NRDC comment was related to the contention that NRC had developed its assessment of the CRBRP fuel cycle from a scale down of a generic analysis of a much larger commercial LMFB industry. In Appendix D of this updated document, the staff has based its assessment on normal operation of the specific facilities projected by DOE to be used for CRBRP fuel cycle activities. (See Figure D.1 and Section D.2 for details of assumptions and bases for assessments. Summaries of environmental considerations and U. S. population doses are in Table D.4 and D.17, respectively.)

The above changes are insignificant in terms of environmental effects.

11.11.4 Radiological Consequences of Fuel Transportation (PMC, A-98, Item 26)

No changes have been made to this section.

11.11.5 Coolant for Fuel Transport Casks (EPA, A-17, Item 2 (4))

No changes have been made to this section.

11.12 Appendix E - Safeguards Related to the CRBRP Fuel Cycle and Transportation of Radioactive Materials

11.12.1 Plutonium Accountability (ECNP, A-46, Item 11)

The response in the FES has been replaced as follows:

The safeguards systems for the CRBRP fuel cycle facilities will employ a variety of material control and accounting (MC&A) components as well as extensive physical security measures. These are broadly

described in Appendix E. Physical security measures--such as access controls, intrusion detection systems, response forces, and communications systems--are viewed as the first line of defense against theft, diversion, or sabotage. Material control measures, such as monitoring programs and special nuclear material (SNM) containment systems, reinforce the protection provided by physical security and provide a background against which material accounting systems can function effectively. A material accounting system performs measurements and maintains records in order to provide positive assurance that all SNM is present. Should a loss occur, accounting systems must be able to determine the general location of a loss and estimate the amount of SNM involved. As a secondary function, accounting systems provide backup loss detection capabilities and help ensure that the physical security and material control systems and not being circumvented.

The 1% measurement uncertainty mentioned in the comment is apparently a reference to the NRC requirement (see 10 CFR 70.51 for details) that a reprocessing licensee must establish a limit of error on a 6-month inventory difference of no more than 1% of the plant's plutonium throughput. In 1977 it was generally assumed that licensed facilities would be used to support the CRBRP. The facilities that the applicants are now proposing to use for reprocessing, plutonium conversion, and core fuel fabrication will be subject to DOE, not NRC, regulations. In their Environmental Report, the applicants specified the expected limits of error for each of these plants: 0.5% of throughput for bimonthly balances in the conversion and fabrication facilities and 0.7% of throughput for yearly balances in the reprocessing plant. In addition to the conventional material accounting capabilities described by these figures, the applicants stated that the conversion, fabrication, and reprocessing facilities will be equipped with prompt accounting systems to provide more sensitive and rapid indications of material loss.

The above changes are insignificant in terms of environmental impacts.

11.13 Other Considerations and Changes

Section 6.1 and 6.2 - In the third paragraph, the reference to FES Section 5.4 has been corrected to 5.6.

Section 7.3 and Appendix E - In this updated document, Appendix E contains a description of the planned safeguards proposed by DOE in ER Am XIV and the staff assessment of those safeguards. Section 7.3 contains a discussion of potential abnormal environmental impacts that could occur as a result of acts of sabotage or theft or diversion of plutonium from CRBRP or its associated fuel cycle or transportation links. Thus, the bulk of the safeguards material is contained in Appendix E.

Section 9.4.1, Paragraph 3 - The response should have referred to Table 9.8 rather than amended Table 9.5.

Appendix D - Note the updated response in Section 11.11.3.

12 DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT SUPPLEMENT TO THE FINAL ENVIRONMENTAL STATEMENT

Comments on the Draft Supplement were received from the organizations and individuals listed below. They are listed in chronological order, according to the date of the comment letter. In parentheses following the name of each commentator are the initials used to identify the commentator in the discussion of the comments in this chapter. In the body of this chapter, the numbers following commentators' initials refer to specific items in the comment letters themselves. These letters are reproduced in Appendix N of this report, and the item numbers have been added to the margin of each letter to aid the reader in identifying the specific comment being addressed in each reply. To further aid the reader, Table A12.1 lists each comment received and the section or sections of the report where it is discussed.

U.S. Department of Agriculture, Economic Research Service (AG)
East Tennessee Development District (ETDD)
Indiana Sassafras Audubon Society (ISA)
Department of the Army, Nashville District, Corps of Engineers (COE)
U.S. Department of Agriculture, Soil Conservation Service (SCS)
Natural Rights Center (NRCtr)
Ohio Citizens for Responsible Energy (OCRE)
U.S. Department of the Interior (DOI)
Lynn Rudmin Chong (LRC)
Louis G. Williams (LGW)
Suzanne Sherbondy (SS)
Marvin I. Lewis (MIL)
Carolínians for Safe Energy (CSE)
U.S. Department of Energy (DOE)
Mary Sinclair (MS)
Wells Eddleman (WE)
Union of Concerned Scientists (UCS)
Sorghum Alliance (SA)
U.S. Department of Health and Human Services, Public Health Service (DHHS)
Sierra Club (SC)
National Resources Defense Council, Inc. (NRDC)
Governor of Tennessee (TEN)
Gary Flack (GF)
Attorney General of Tennessee (OAG)
U.S. Environmental Protection Agency, Region IV (EPA)
Charles W. Elliott (CWE)
Southwest Research and Information Center (SRIC)
California Energy Commission (CEC)
William A. Lochstet (WAL)

12.1 Summary and Conclusions, Introduction

DOE-A and -B--Plant Size and Output: The text has been corrected to reflect these comments.

Table A12.1 Cross-reference list of comments on the Draft Supplement to the FES and the section(s) in this report where they are addressed

Commentor	Supplement Section(s)	Commentor	Supplement Section(s)	Commentor	Supplement Section(s)
AG	*	MIL-2	12.8.3,	DOE-V	12.9.2
ETDD	*		12.8.4,	DOE-W	12.9.2.6
ISA-1	12.8.1		12.9.1	DOE-X	12.9.2.6
ISA-2	12.10.4.2	MIL-3	12.7.1.2	DOE-Y	12.12.D.2
COE	*	MIL-4	12.10.4.2	DOE-Z	12.12.J.2
SCS-1	12.2.7.1	CSE-1	12.12.E.1	DOE-AA	12.12.J.2
NRCtr	12.2.7.2	DOE-A	12.1	DOE-BB	12.12.L.1.1, -3,
OCRE-1	12.8.1	DOE-B	12.1		-4, 12.12.L.2.1
OCRE-2	12.8.1	DOE-C	12.2.5.3	DOE-CC	12.12.L.1.1
OCRE-3	12.12.J.2	DOE-D	12.2.5.3	DOE-DD	12.12.L.1.1
OCRE-4	12.12.E.1	DOE-E	12.2.7.2	DOE-EE	12.12.L.1,
OCRE-5	12.4.5.3	DOE-F	12.2.7.2		12.12.L.2.2
OCRE-6	12.10.4.1	DOE-G	12.3.6.9	DOE-FF	12.2.7.2
OCRE-7	12.4.4.2	DOE-H	12.3.8	MS-1	12.8.4
OCRE-8	12.11.7.16	DOE-I	12.3.8	MS-2	12.12.E.1
OCRE-9	12.5.7.2	DOE-J	12.4.5.6	MS-3	12.12.E.8
OCRE-10	12.5.7.2	DOE-K	12.4.6.1	MS-4	12.10.2.4
DOI	*	DOE-L	12.4.6.1	WE-1	12.12.J.1
LRC-1	12.10.2.4	DOE-M	12.5.7.2	WE-2	12.12.J.1
LRC-2	12.5.7.2,	DOE-N	12.6.1.6	WE-3	12.12.J.1
	12.10.2.4	DOE-O	*	WE-4	12.12.J.1
LRC-3	12.10.2.4	DOE-P	12.9.2	WE-5	12.12.J.2,
LRC-4	12.10.2.4	DOE-Q	12.9.2		12.12.L.1.2
LGW-1	12.6.2.2	DOE-R	12.9.2,	WE-6	12.12.J.2
SS-1	12.5.7.2		12.9.2.4	WE-7	12.12.J.2
SS-2	12.5.7.2	DOE-S	12.9.2	WE-8	12.12.J.2
SS-3	12.5.7.2	DOE-T	12.9.2	WE-9	12.10.4.1
MIL-1	12.10.4.3	DOE-U	12.9.2	WE-10	12.10.4.1

*No comment necessary.

Table A12.1 (Continued)

Commentor	Supplement Section(s)	Commentor	Supplement Section(s)	Commentor	Supplement Section(s)
WE-11	12.10.4.1	NRDC-4	12.2.5,	NRDC-32	12.4.4.2
WE-12	12.10.4.1		12.5.7.2	NRDC-33	12.4.4.2
WE-13	12.10.4.1	NRDC-5	12.2.5	NRDC-34	12.5.7.2
WE-14	12.12.E.6	NRDC-6	12.2.5.3,	NRDC-35	12.5.7.2
WE-15	12.12.L, -1.2		12.5.7.2	NRDC-36	12.5.7.2
UCS-1	12.12.J.2	NRDC-7	12.2.5.3	NRDC-37	12.5.7.2
UCS-2	12.12.J.1	NRDC-8	12.2.5.3	NRDC-38	12.5.7.2
UCS-3	12.12.J.2	NRDC-9	12.2.6	NRDC-39	12.5.7.2, -3,
UCS-4	12.12.J.2	NRDC-10	12.2.7.1		12.5.8
UCS-5	12.9.2	NRDC-11	12.2.7.1	NRDC-40	12.6.1.3
SA-1	12.12.E.8	NRDC-12	12.2.7.2	NRDC-41	12.6.1.4
SA-2	12.8.1	NRDC-13	12.8.3	NRDC-42	12.5.7.2
SA-3	12.8.4	NRDC-14	12.3.3	NRDC-43	12.7.1.1
SA-4	12.8.4.4	NRDC-15	12.3.4.1	NRDC-44	12.7.2
DHHS-1	*	NRDC-16	12.3.5	NRDC-45	12.7.3
DHHS-2	*	NRDC-17	12.3.5	NRDC-46	12.12.D.1
DHHS-3	*	NRDC-18	12.3.5	NRDC-47	12.9.2.4
DHHS-4	12.11.7.16	NRDC-19	12.3.5	NRDC-48	12.9.2.4
DHHS-5	12.5.7.2	NRDC-20	12.3.5	NRDC-49	12.9.2.4
DHHS-6	*	NRDC-21	12.3.5	NRDC-50	12.9.2.4
SC-1	12.10.2.4	NRDC-22	12.3.5	NRDC-51	12.9.2.4
SC-2	12.10.2.4	NRDC-23	12.3.5.3	NRDC-52	12.9.2.5
SC-3	12.10.2.4	NRDC-24	12.3.5.3	NRDC-53	12.9.2.5
SC-4	12.10.4.2	NRDC-25	12.3.6	NRDC-54	12.9.2.5
SC-5	12.10.2.4	NRDC-26	12.4.2	NRDC-55	12.10.4.2
SC-6	12.10.2.4	NRDC-27	12.4.4.1	NRDC-56	12.9.2.5
SC-7	12.10.2.4	NRDC-28	12.4.4.2	NRDC-57	12.9.2.6
NRDC-1	12.1.3	NRDC-29	12.4.4.2	NRDC-58	12.9.2.6
NRDC-2	12.2.1	NRDC-30	12.2.7.2	NRDC-59	12.9.2.6
NRDC-3	12.2.1	NRDC-31	12.4.4.2	NRDC-60	12.9.2.6,
					12.10.4.2

*No comment necessary

Table A12.1 (Continued)

Commentor	Supplement Section(s)	Commentor	Supplement Section(s)	Commentor	Supplement Section(s)
NRDC-61	12.9.2.7	NRDC-91	12.5.7.2,	NRDC-122	12.12.J.2
NRDC-62	12.9.2.6		12.11.6.7	NRDC-123	12.12.J.2
NRDC-63	12.9.4	NRDC-92	12.11.7.12	NRDC-124	12.12.J.2
NRDC-64	12.10.1.1	NRDC-93	12.12.D.1	NRDC-125	12.12.J.2
NRDC-65	12.5.3.2,	NRDC-94	12.12.D.1	NRDC-126	12.12.J.2
	12.10.1.1	NRDC-95	12.12.D.2	NRDC-127	12.12.L
NRDC-66	12.10.1.1	NRDC-96	12.12.D.2	NRDC-128	12.12.L.1
NRDC-67	12.10.1.2	NRDC-97	12.12.D.2	NRDC-129	12.12.L
NRDC-68	12.10.1.2	NRDC-98	12.12.D.2	NRDC-130	12.12.L
NRDC-69	12.5.3.1	NRDC-99	12.12.D.2	NRDC-131	12.12.L
NRDC-70	12.5.3.2	NRDC-100	12.12.D.2	NRDC-132	12.12.L.1
NRDC-71	12.10.1.3	NRDC-101	12.12.D.2	NRDC-133	12.12.L.1.1
NRDC-72	12.10.2.4	NRDC-102	12.12.D.2	NRDC-134	12.12.L.1.1
NRDC-73	12.10.2.4	NRDC-103	12.12.E.1	NRDC-135	12.12.L
NRDC-74	12.10.2.4	NRDC-104	12.12.E.2	NRDC-136	12.12.L,
NRDC-75	12.10.2.4	NRDC-105	12.12.E.2		12.12.L.1.2
NRDC-76	12.10.2.4	NRDC-106	12.12.E.2	NRDC-137	12.12.L,
NRDC-77	12.10.2.4	NRDC-107	12.12.E.3		12.12.L.1.3
NRDC-78	12.10.2.4	NRDC-108	12.12.E.3	NRDC-138	12.12.L,
NRDC-79	12.10.2.4	NRDC-109	12.12.E.4		12.12.L.1.4
NRDC-80	12.10.3	NRDC-110	12.12.E.6	NRDC-139	12.12.L
NRDC-81	12.10.4.1	NRDC-111	12.12.E.6	NRDC-140	12.12.L.1.4
NRDC-82	12.9.2.5	NRDC-112	12.12.E.8	NRDC-141	12.12.L.1.1
NRDC-83	12.10.4,	NRDC-113	12.7.1.1	NRDC-142	12.12.L.1
	12.12.L	NRDC-114	12.12.J.2	NRDC-143	12.12.L.1
NRDC-84	12.10.4.2	NRDC-115	12.12.J.2	NRDC-144	12.12.L.2.1
NRDC-85	12.10.4.2	NRDC-116	12.12.J.2	NRDC-145	12.12.L.2.1
NRDC-86	12.10.4.2	NRDC-117	12.12.J.2	NRDC-146	12.12.L.2.1
NRDC-87	12.10.4.3	NRDC-118	12.12.J.2	NRDC-147	12.12.L.2.1
NRDC-88	12.11.1.7	NRDC-119	12.12.J.2	NRDC-148	12.12.L.2.1
NRDC-89	12.11.2.15	NRDC-120	12.12.J.2	NRDC-149	12.12.L.2.1
NRDC-90	12.11.2.16	NRDC-121	12.12.J.2	NRDC-150	12.12.L

Table A12.1 (Continued)

Commentor	Supplement Section(s)	Commentor	Supplement Section(s)	Commentor	Supplement Section(s)
NRDC-151	12.12.L.2.2	EPA-3	12.11.7.13	CWE-4	12.12.J.2
NRDC-152	12.12.L.2.2	EPA-4	12.1, -1.1	CWE-5	12.12.J.2
NRDC-153	12.12.L.2.2	EPA-5	12.1.4	SRIC-1	12.12.D.2
NRDC-154	12.12.L.2.2	EPA-6	12.2.5.3	SRIC-2	12.5.7.2
NRDC-155	12.12.L	EPA-7	12.3.3	SRIC-3	12.5.7.2
NRDC-156	12.12.L.2.3	EPA-8	12.3.3	SRIC-4	12.12.D.2
NRDC-157	12.12.L.2.3	EPA-9	12.3.3	SRIC-5	12.5.7.2
NRDC-158	12.12.L.2.3	EPA-10	12.3.3	SRIC-6	12.12.E.8
NRDC-159	12.12.L.2.3	EPA-11	12.3.3	CEC-1	12.8.4
NRDC-160	12.12.L.2.3	EPA-12	12.4.4.2	CEC-2	12.7.3,
NRDC-161	12.12.L.2.2	EPA-13	12.2.7.1, -2,		12.8.4.7
NRDC-162	12.12.L		12.4.4.2	CEC-3	12.12.E.3,
NRDC-163	12.12.L.3	EPA-14	12.5.3.2		12.12.J.2
NRDC-164	12.12.L.3	EPA-15	12.6.1.4	CEC-4	12.3.5.3,
NRDC-165	12.12.L	EPA-16	12.10.2.4		12.12.D.2
TEN-1	12.4.5	EPA-17	12.11.4.10	CEC-5	12.12.D.2
GF-1	12.10.2.4	EPA-18	12.11.7.13	CEC-6	12.10.2.4
GF-2	12.10.4.3	EPA-19	12.5.7.2	WAL-1	12.7.1.3
OAG-1	12.4.5	CWE-1	12.11.7.16	WAL-2	12.5.7.2,
OAG-2	12.4.5	CWE-2	12.7.1.3		12.12.D.2
EPA-1	12.2.7.1, -2	CWE-3	12.12.J.2	WAL-3	12.5.7.2
EPA-2	*				

*No comment necessary

EPA-4--Core Fuel Composition: The license will permit only the particular fuel feed stock specified in the application, for which adequate safety analysis is being made. Later amendments to the license involving variations in fuel, if offered, will be reviewed to ensure that the public risks are not increased.

12.1.1 The Proposed Project

EPA-4--Licensing Period: The applicants have requested a construction permit and operating license for a 40-year period that would begin with issuance of the NRC construction permit. (See Section 12.3.5 for a discussion of the radiological source term.)

12.1.3 Status of the Project

NRDC-1--Current Licensing Status: The last two paragraphs on page 1-1 have been updated. Recent experience with commercial power reactors indicates construction duration times from approximately 6 years (St. Lucie 2) to 14 years (Diablo Canyon 2). Considering that experience, the applicants' schedule for completion of CRBRP appears optimistic but possible.

12.1.4 Status of Reviews and Approvals

EPA-5--NPDES: This information has been added to the text.

12.2 The Site and Environs

12.2.1 General Description

NRDC-2--Tennessee Synfuels Associates: The Environmental Impact Report (EIR) for the Tennessee Synfuels Associates (TSA) facility indicates that the proposed plant is to be located northwest of the Oak Ridge Gaseous Diffusion Plant (ORGDP), about 2.5 miles north of the CRBR site. Recent discussions with TSA executives indicate uncertainty as to actual plant construction. The EIR indicates that, when the TSA facility is at its ultimate production capacity, using 29,000 tons of coal per day, it will produce 42,500 barrels per day of gasoline, 7500 barrels per day of liquified petroleum gas, 550 tons per day of sulfur, and 125 tons per day of anhydrous ammonia. Potential accidents at the TSA facility could result in fires and/or explosions and releases of anhydrous ammonia. Based on past review experience, the staff does not expect fires and/or explosions at the TSA plant to pose a hazard to the safe operation of CRBR; however, possible releases of anhydrous ammonia may require automatic detection and control room isolation capability for the CRBR. If the TSA facility is built, the staff will assess the effects of accidents at the TSA facility upon CRBR, and will require CRBR design modifications, as necessary, to safely accommodate such events.

NRDC-3--Implications of DRP on CRBRP Siting: Several locations on the Oak Ridge Reservation are apparently being considered for construction of a developmental reprocessing plant (DRP). Until DOE determines what its plans for the DRP will be, there is no meaningful basis for an NRC analysis of potential interactions of the two facilities. (See also Section 11.9.5 of the FES, which presents the staff's remarks relative to co-location of the CRBRP with fuel cycle facilities.)

If the proposed DRP were to be built, the staff judges that accidents associated with a proposed DRP, to be located about 2 miles east of the Clinch River site, can be safely accommodated by the CRBR design, either as it exists today or with appropriate modifications. The accidents of consequence to CRBR are those involving substantial releases of toxic and/or radioactive materials from the reprocessing plant, which can be accommodated by appropriate control room detection and isolation capability in CRBR. If the reprocessing plant is built, the staff will assess such accidents and will require CRBR design modifications, as necessary, to safely accommodate such events.

12.2.5 Hydrology

NRDC-4--Radioactive Discharge Effect on Water Supplies: See the response in Section 12.5.7.2 below.

NRDC-5--Clinch River Flow Reversals: No significant increase or decrease in calculated doses would be expected because of flow reversals in the Clinch River. Flow reversals would be rare events that occur under certain operating conditions of the locks and dams on the Clinch River and Tennessee River. Doses are calculated for the maximum exposed individual on a yearly exposure basis, and would not be greatly affected by flow reversals, which would occur only a very small fraction of the time, if at all. Extended periods of zero flow have occurred in the past because of deliberate operations to destroy milfoil, and are not expected to occur again. On a yearly average, however, the calculated doses would not have been greatly affected by the historic periods of zero flow.

12.2.5.3 Floodplain Effects

DOE-C--Spoil Areas: The reference to spoil areas in the floodplain has been deleted.

DOE-D--Treatment Ponds: The correction has been made.

EPA-6--Spoil Disposal: The text has been changed to reflect these changes.

NRDC-6--Floodplain Effects: Because the Department of Energy is a party to the Clinch River project, the plant has already been reviewed by DOE for compliance with its own interpretations of Executive Order 11988. NRC is not bound by the DOE interpretation of Executive Order 11988 and has conducted its own independent review (see Section 2.5.3).

NRDC-6--Clinch River Site, Alternatives: The staff evaluated the applicants' analyses of floodplain alternatives and concluded that there were no reasonable alternatives to the plant features located in the floodplain. In response to the NRDC request for a discussion of alternatives, the applicants have discussed alternatives for the railroads, onsite roads, barge-unloading facility, intake structure, discharge structure, and runoff treatment ponds in response to staff question 240.1.

Obviously, no nonfloodplain alternative exists for the intake structure, which must be located in the river. The discharge structure is located in the river to afford rapid mixing of effluents in order to minimize environmental impacts.

The barge-unloading facility must be located adjacent to the river in the floodplain. No reasonable alternative to barging, such as rail or road transport, exists because of the heavy weight and large size of some of the components of the plant.

The presently proposed onsite road closely follows the alignment of an existing road. Alternative routes would either be located totally within the floodplain or pass through terrain requiring additional clearing, excavation, and embankment fill at high cost.

The applicants have explored alternatives to the presently proposed routes of the onsite and offsite railroads. Alternative onsite routes would either be totally within the floodplain or adjacent to steep hills, necessitating extensive earthwork. The offsite railroad was designed to have the minimum practical floodplain impacts by careful routing, and by design features such as the placement of fill to minimize the width of the roadbeds.

The staff concurs with the applicants' analysis of all alternatives to Clinch River plant features located in the floodplain.

The staff's conclusions about the acceptability of the site in terms of Executive Order 11988 reflected the staff's judgment that there would be little disturbance of the 100-year floodplain because virtually all site features are on high ground and that there were no reasonable alternatives to the relatively small amount of disturbance of the floodplain. In addition, some of the floodplain land which will be used has previously been graded and stabilized and is not virgin floodplain.

NRDC-6a--Measurability of Floodplain Effects: The site is in a highly controlled river basin. The reduction in Clinch River flow cross-sectional area is so small that it is unlikely that any features built on the site would affect the flood levels upstream or downstream from the site.

NRDC-6a--Alternative Sites: Alternative sites have been considered, and are presented in Appendix L of this statement. Only reconnaissance-level data were used in most cases, so a detailed evaluation could not be performed. Although some of the alternative sites have construction permits, they predated Executive Order 11988, so no floodplain studies were available.

NRDC-6b--Acceptability to State and Local Standards: The CRBRP is located on land held by the Federal government, so no state or local floodplain regulations apply.

NRDC-6c--Critical Action Floodplain: The intent of Executive Order 11988 has been fulfilled because the entire plant island is above the level of the probable maximum flood (PMF). It is well known that the PMF, being the worst flood which could reasonably be expected to occur at the site because of combinations of natural phenomena, is a much less probable, and more severe, event than the 500-year flood. Nevertheless, the applicants have evaluated the effects of the 500-year flood in the vicinity of the site. The same structures affected by the 100-year flood would be affected by the 500-year flood. No additional structures, appurtenances, or "hazardous parts of the plant" would be inundated by the 500-year flood.

NRDC-6c--Barge-Unloading Facility Location: The barge-unloading facility is located on the east bank of the Clinch River at CRM 14.8+. This location, which differs from that in the 1977 FES, represents a design development that minimizes potential environmental impact from dredging.

NRDC-7--Location of Proposed Barge-Unloading Facility: The proposed barge-unloading facility is located at CRM 14.8.

NRDC-8--Barging vs. Rail Shipment: The primary function of the barge-unloading facility is to furnish an economical, practical transportation means for major plant components (reactor vessel, etc.), some of which are already fabricated. The railway system can accommodate neither the sizes nor the weights of the largest components.

12.2.6 Meteorology

NRDC-9--Heavy Fog: The annual frequency of heavy fog referenced is based on 14 years of observations made at the Oak Ridge office of the National Weather Service. The annual frequency of heavy fog at Oak Ridge is comparable to that observed over a 34-year period at Knoxville. These observations provide a reasonable indication of occurrences of heavy fog at the CRBR site. However, local occurrences of heavy fog are dependent on proximity to large bodies of water, and heavy fog is expected to occur slightly more frequently at the CRBRP site. Therefore, the applicants have committed to the establishment of a fog monitoring program during plant construction to provide a "baseline" of naturally occurring fog from which the impact of plant operation can be assessed at the OL review.

For those times when the fog does interact with the radioactive effluents, the following can be expected: The noble gases will have little or no affinity for the fog droplets; some of the iodines (e.g., elemental) will be readily adsorbed by the fog. Radioactive particulates may act as condensation nuclei to induce coalescence between the fog and particulates. Iodines and particulates that combine with fog will be more readily deposited onto surfaces. This will result in an increase in the deposition rate of the iodines and particulates during those periods when the meteorological conditions are favorable for the radioactive effluents to interact with the fog.

Based on the fact that no significant impact from radioactive effluents interacting with fog has been observed from other existing nuclear plants, any impact from this interaction is expected to be negligible. See also ER Sections 5.1 and 10.1.

12.2.7 Ecology

12.2.7.1 Terrestrial

EPA-1 and -13--Endangered Species: See response in Section 12.2.7.2.

NRDC-10--Flora and Mammals: Section 4.4.1 has been modified to reflect this comment. In addition, Section 4.6.1.1 (item 16) of the Draft Supplement indicated that "critical ecological elements" will be inspected and site preparation activities will be modified, if required, for the preservation of these

critical ecological elements. Cimicifuga rubifolia and Saxifraga careyana are included in the term "critical ecological elements" and, therefore, will be protected from construction activities.

Although infrequently observed on the Oak Ridge reservation, bobcats apparently used the Oak Ridge reservation and surrounding areas, including the Clinch River site (Chestnut Ridge area), for foraging activities. Old field habitat where the preferred food (cottontail rabbits and cottonrats) abounds are widely scattered throughout the Oak Ridge Reservation and, therefore, the population of bobcats at Oak Ridge Reservation requires a large home range for foraging activities. The staff believes that construction and operational activities on part of the Clinch River site would not adversely affect the availability of suitable foraging habitat for the existing population of bobcats on the Oak Ridge reservation because of the bobcats' large home-range requirements.

As indicated in this comment, the staff performed a biological assessment of the endangered grey bat and concluded that construction and operational activities at the Clinch River site would not affect this species. The Fish and Wildlife Service reviewed this assessment and concurred with its conclusions (Appendix B).

In its assessment* of the impacts of the CRBRP on the grey bat, the staff concluded that potential grey bat foraging habitat along the river would be sufficiently protected by the minimum 25-ft-wide vegetation border as outlined by the applicants' Erosion and Sediment Control Plan (see also Section 4.2.2). The staff agrees with the comment that there is a potential for disturbances along the river resulting from noise and human presence normally associated with construction activities. However, the staff in its assessment concluded that habitat critical to the existence of this species, if any, would not be significantly impacted by construction activities. The staff believes that construction noise and other construction activities would also not significantly affect foraging habitat critical to the grey bat.

NRDC-11--Birds: As indicated in the Draft Supplement, although one Federally Listed species (the bald eagle) and four state-listed species have been observed on the site; none of these species were observed to use the site for nesting activities.

Furthermore, the staff as a result of its informal discussions with the Fish and Wildlife Service determined that the Clinch River site offered no unique or critical habitat necessary for the continued existence of populations of bald eagles (see Appendix B). It is also the staff's conclusion in reference to the state-listed species that the Clinch River site offers no unique or critical habitat for these species. Therefore, construction and operational activities would not adversely affect these species.

*P. Check, NRC, letter to W. C. Hickling, U.S. Fish and Wildlife Service, August 16, 1982, with attachment entitled "Assessment of the Impacts of the Clinch River Breeder Reactor Plant on Threatened or Endangered Species," by M. T. Masnik and G. G. Gears.

The staff's biological assessment on the grey bat, as requested by the Fish and Wildlife Service, was reviewed by that agency, which concurred with the staff's findings (see also the response to NRDC-10 and Appendix B).

SCS-1--Soil Erosion: The Soil Conservation Service District Office reviewed and concurred in the Erosion and Sediment Control Plan.

12.2.7.2 Aquatic Ecology

EPA-1 and -13--Endangered Species: The results of the Fish and Wildlife Service review of the staff's Biological Assessment are provided in Appendix B. The Fish and Wildlife Service concurred with the staff's conclusions in its Biological Assessment that construction and operational activities at Clinch River would not affect any Federally listed threatened or endangered species.

DOE-E and -FF--Sauger Spawning Study: The staff has reviewed the data submitted with the comment. Appropriate changes in the text have been made to reflect this comment.

DOE-F--Sauger Study: The text has been revised to reflect this comment.

NRCtr-1--Endangered Species: The Tennessee Wildlife Resources Commission has declared the reticulate logperch, Percina sp. (cf. P. caprodes) as threatened. The reticulate logperch is an undescribed species similar to P. caprodes (hence the use of cf.) and known only from the Conasauga River, upper Coosa drainage. The Conasauga River is outside the Tennessee River system, but partially in the State of Tennessee. The species known from the Clinch River in the vicinity of the proposed site is a different species, Percina caprodes, the logperch. The only other similar species occurring in the Tennessee River drainage that possibly could cause confusion is Percina burtoni, the blotchside logperch. This species is not considered threatened or endangered by either the State of Tennessee or the Federal government.

NRDC-12--Endangered Species: The U.S. Fish and Wildlife Service (FWS) (Appendix B) concurs with the conclusion presented in the NRC-prepared Endangered Species Act Section 7 Consultation that this project will have no effect on the Federally listed species provided in Appendix B. The FWS has statutory jurisdiction over the listed species and possesses the necessary expertise in implementing the Endangered Species Act. The staff therefore concludes that the NRC requirements for addressing these species under the provisions of the Endangered Species Act is complete at this time. The NRC recognizes, however, that if new information becomes available that potentially could result in a change in the conclusions of this assessment, the staff is required to consult with the FWS at that time. The arguments presented by NRDC do not represent sufficient new information that could potentially alter the conclusions.

NRDC-29--Striped Bass: See response to NRDC-29 in Section 12.4.4.2.

NRDC-30--Blue Sucker: On April 19, 1982, an additional specimen of Cycoreus enlongatus was taken from CRM 12.0 incidental to a sauger study by TVA biologists. This increases the recent known records of this species in Watts Bar Lake to three.

The NRC Biological Assessment submitted to the FWS pertains only to Federally recognized species. The blue sucker was not included in the biological assessment because it is not listed as a protected species under the U.S. Endangered Species Act. It is, however, a state-listed threatened species and, as such, comes under the jurisdiction of the Tennessee Wildlife Resources Commission.

OCRE-7--Asiatic Clams: See response to OCRE-7 in Section 12.4.4.2.

12.3 Facility Description

12.3.3 Water Requirements

EPA-7--Figure A3.4: Information has been added to Figure A3.4 in response to this comment.

EPA-8--NPDES Permit: The suggested correction has been made.

EPA-9--Metal Cleaning Waste: The suggested change has been made.

EPA-10--Treatment Pond C: The correction has been made.

EPA-11--Permit Limits: The changes have been made.

NRDC-14--Water Requirements: The revisions in the water use figures are the result of progression of the design.

The range in the actual flow values that will be experienced at the station is expected to exceed the change in nominal values reported in the Draft Supplement. With the station using a small percentage of the minimum monthly river flow (less than 1%), water availability was not of significance in the 1977 FES. The newly calculated nominal water use values do not alter that finding.

12.3.4 Heat Dissipation System

12.3.4.1 Cooling System

NRDC-15--Heat Dissipation Cooling System: The aspects of the cooling tower design that could result in atmospheric impacts--i.e., visible plumes, ground fogging, and icing and drift deposition--are very similar between the old and new tower design parameters. The differences between the old and new designs are as follows: The new heat rejection rate is slightly lower, the air flow rates are virtually the same, the drift rates are virtually the same, the new evaporative losses are slightly less, and the new towers are slightly taller. The overall impact of these modifications of the design should be to reduce the potential atmospheric impacts as compared with the impacts described by the applicants in the ER and the staff in the FES.

12.3.5 Radioactive Waste Systems

NRDC-16--Design Objectives of 10 CFR 50, Appendix I: The staff still believes that the design objectives of 10 CFR 50, Appendix I, should be the criteria that are used to determine whether CRBRP radioactive releases are ALARA.

In the 1977 FES, the staff assumed that the design objectives of Appendix I to 10 CFR 50 are applicable for determining whether CRBRP radioactive releases are ALARA. In the FES, the staff performed an evaluation to determine if the waste management systems meet the design objectives of the Annex to Appendix I. Since publication of the FES, the staff has refined and supplemented the Appendix I evaluation contained in the FES by performing a cost-benefit analysis for the addition of augments to the liquid and gaseous radioactive waste systems. For the purpose of assessing the need for augmenting the radwaste system, values of \$1000 per total body person-rem and \$1000 per person-thyroid-rem are prescribed in Section II.D of Appendix I to 10 CFR 50. In view of the expected low population doses (see Section 5.7 of this supplement), it is clear that the maximum justified annual expenditure for any augments would be substantially less than \$1000. Potential radwaste system augments and their costs are listed in Regulatory Guide 1.110. When this list is examined, it becomes obvious that there are no available augments whose costs do not far exceed \$1000. Thus, the staff concludes that the liquid and gaseous radwaste treatment systems will reduce liquid radioactive effluents to ALARA levels in accordance with 10 CFR 50.34a, Appendix I to 10 CFR 50, and the Annex to Appendix I to 10 CFR 50.

NRDC-17--PWR-GALE Code: The GALE Code was modified to account for the fact that the primary coolant in the CRBRP will be sodium, not water. This was necessary to determine the primary and secondary expected radionuclide concentrations. The code was also modified to include the intermediate activity system and the low activity system processing scheme.

NRDC-18--Decontamination Factors: The decontamination factors were developed using the principles described in NUREG-0017, and are based on operating experience of systems used in light water reactors that are similar to those being employed in the CRBRP.

Detailed discussions of activity levels, relationship of activity levels to percentage cladding failure, and parametric analysis using various percentages of cladding failure are beyond the scope and intent of an environmental statement.

The value of 0.5% fuel cladding failure was determined through a staff study of expected fuel failure rates for LMFBF cores. The staff feels that the value contains sufficient conservatism that it will not be exceeded.

NRDC-19--Balance of Plant Releases: The reason that the liquid tritium source term has been reduced from 330 Ci/yr to 2.3 Ci/yr is design changes in the cold traps that allow a much greater trapping efficiency for tritium.

NRDC-20 and -22--Liquid and Gaseous Waste Summary: The value of 0.016, excluding tritium and dissolved gases, was determined using the PWR GALE Code, as modified for the CRBRP, and is the sum of the individual radionuclide contributors, as shown in Table 3.3 of the 1977 FES.

The values for the parameters in question are shown in Table 3.2 of the 1977 FES and in NUREG-0017. The applicants' values are given in Section 3.5 of the Environmental Report. A detailed comparison of the staff's values and the applicants' values and how use of these values led to the final results is beyond the intent and scope of an environmental statement.

The applicants' radioactive liquid waste effluent calculations have increased because of minor design changes in the liquid radwaste system. The staff feels that the 1977 FES estimates of liquid radioactive waste effluents from the CRBRP are sufficiently conservative and do not need to be recalculated.

NRDC-21--Gaseous Waste: The staff still considers the dose limits in 10 CFR 50, Appendix I, to be applicable for the CRBRP.

The applicants' value of 700 Ci/yr for noble gases has been found to be in error. The applicants have subsequently modified the value for noble gases to 210 Ci/yr. Their analysis was performed using a value of 0.1% failed fuel. The staff used a value of 0.5%, which is considered by the staff to be reasonably conservative.

12.3.5.3 Solid Waste

CEC-4--Waste Management: See the response to CEC-4 in Section 12.12.D.2.

NRDC-23--Solid Waste: Estimates of the amount of radioactivity that will be contained in solid waste have increased as a result of the applicants' efforts to improve the design of the radwaste treatment systems so that the amount of radioactivity that is released from the plant in liquid or gaseous form can be minimized. The staff has examined the range of activity levels and finds them to be reasonable for a plant the size of CRBRP.

NRDC-24--Solid Waste Storage: Details on the mode of storage, length of storage, location of storage, and whether or not the waste will be stored or shipped off site are being developed by the applicants. The staff has given the applicants until the operating license stage of the review to work out the answer to these questions. See also the response to CEC in 12.12.D.2. These issues will be considered in future actions.

12.3.6 Chemical Effluents

NRDC-25a, b, and c--Chemical Effluents: EPA has revised the NPDES permit rationale to include a discussion of Tennessee Water Quality Standards requirements relative to copper.

Effluents have been evaluated with regard to Tennessee Water Quality Standards. Criteria for toxic pollutants are provided in Chapter 1200-4-3.01(3)(c)7 of the Rules of the Tennessee Department of Public Health for Fish and Aquatic Life and are as follows:

Toxic Substances - There shall be no substances added whether alone or in combination with other substances that will adversely affect fish or aquatic life. The instream concentrations of toxic pollutant shall not exceed 1/10 of the 96-hour LC_{50} based upon available data using one or more of the most sensitive organisms significant to the aquatic community of the waters under consideration. Where there are substances that are toxic due to their cumulative characteristics, other limiting concentrations may be specified on a case by case basis within the discharge permit when factually justified and approved by the Commissioner of the Tennessee Department of Public Health. In no event shall the diversity or productivity of biota significant to the

aquatic community of the receiving stream be decreased based upon a 96-hour LC₅₀ criterion and the appropriate application factor. References to be used in determining toxicity limitations shall include, but not limited to: Quality Criteria for Water (Section 304(a) of PL 92-500), Federal Regulations under Section 307 of PL 92-500, and Federal Regulations under Section 1412 of the Public Health Service Act as amended by the Safe Drinking Water Act (PL 93-523). The use of such information should be limited to that part applicable to the aquatic community found within the receiving stream or waters under consideration.

Ambient, expected effluent and LC₅₀ data values have been compared for specific parameters. The comparison utilizes LC₅₀ data for fathead minnow and for other species for which LC₅₀ data are available. Fathead minnow is one of the normal indicator organisms used by EPA and other researchers for toxicity evaluations. LC₅₀ data for representative sensitive fish species have been utilized even though planktonic fish food organisms such as Daphnia may have LC₅₀ values which are lower than the fish species assessed. This was due to two factors. First, fish are mobile and might remain in the vicinity of the discharge for periods long enough for acute toxicity conditions to occur. However, the planktonic fish food organisms float with the current and do not remain in the vicinity of discharge for extended periods. Secondly, instream assessments have been made at the edge of a 20-meter mixing zone where a 13 to 1 dilution occurs rather than after complete mixing (i.e., more than 100 to 1) in the Clinch River.

Data for all parameters compared, with the possible exception of copper, indicate that compliance with the toxic substances clause of the Tennessee Water Quality Standards should be achieved by the plant discharge. Compliance is demonstrated because the expected effluent concentrations are less than the LC₅₀ values and concentrations at the edge of the proposed mixing zone can be demonstrated to be less than 10% of the LC₅₀ values. To assure this compliance, intake and effluent monitoring are required by the NPDES Permit, Part III.C., for selected parameters subsequent to plant operations.

In the case of copper, however, absolute certainty cannot be assured at this time based on ambient data at Clinch River Mile 17.9. Data at CRM 10.0 indicates an average value for total copper of 5.6 µg/l. If the ambient value of 5.6 exists at the site, assurance of compliance with the toxic substance clause could be made without further consideration. However, ambient data collected at CRM 17.9 indicate an average of 36.5 µg/l. This discrepancy may be due in part to slightly different sampling or analytical methods or factors related to river conditions at the two locations. Even if actual concentrations of total copper at the plant site average 36.5 µg/l, it must be noted that a reasonable fishery and food chain population presently exists at the site which would be inconsistent with LC₅₀ data available for the indigenous species. This may be due in part to the criteria development procedure. Most LC₅₀ data is developed utilizing soluble copper (cupric ion) which is typical of most industrial dischargers of copper. However, in the case of CRBRP, increased total copper in the plant discharge is primarily due to concentration of background materials by evaporation of pure water in the cooling tower system. This evaporation leaves behind the pollutants which are in the intake water in a concentration of about two and one-half times that in the plant intake. Regeneration of demineralizers likewise returns pollutants which were removed

from the intake water in process water treatment. While some very minimal amount of copper may be added due to corrosion and erosion of condenser tubing, sedimentation of river silt and other suspended material containing copper is likely to result in a net decrease in the total pounds per day of copper returned to the River compared to that which is removed from the River by the plant intake. Unlike the soluble copper used in development of toxicity criteria, ambient concentrations of total copper in the River (and returned in the plant discharge) are likely to be in combined form as part of the sediment load or suspended solids which are not readily available to aquatic organisms and are therefore not likely to be as toxic.

A provision is included in the NPDES permit (Page I-1 and Part III.9) requiring the permittee to comply with the toxic substances clause both in the discharge and at the edge of the mixing zone. However, as noted above, a specific numerical limitation has not been provided in the NPDES permit at this time. Because of the presence of ambient data at the site which indicate that copper exceeds or potentially exceeds the toxic substances clause of the Tennessee Water Quality Standards, Special Conditions III.P, III.Q and III.R have been incorporated into the draft NPDES Permit. Parts III.P and Q require that the applicant conduct a sampling and analysis program for both total and dissolved copper and submit an assessment assuring his ability to comply with Tennessee Water Quality Standards requirements. This report will include an assessment of alternatives, remedial actions, and an implementation schedule to provide corrective actions, if necessary, prior to plant operation. Additionally, Part III.R. requires the permittee to conduct approved toxicity screening tests on the actual plant effluent to ensure that Tennessee Water Quality Standards requirements are met. Approval of the testing methods and procedures as well as evaluation of results will be coordinated with the State of Tennessee. Also see NPDES Permit Rationale II.A.2 and Table 1 in Appendix H.

NRDC-25d(1)--Discharge Regulations: The proposed NPDES permit specifically allows discharges from two presently proposed treatment facilities (extended aeration, activated sludge) that were designed based on the presently anticipated work force. However, should those estimates change as a result of increased or decreased levels of construction, process modifications could be instituted to allow acceptable treatment of either higher or lower waste flows at the proposed units. The proposed NPDES permit acknowledges this fact and allows reconsideration at a future date as well as the possible addition (or removal) of treatment units from service should the need arise. Process modifications would result in limited, not "great," increases in flow through a unit; however, additional units could process higher flows. NPDES and state regulations require the applicants to amend the applications and submit plans, specifications, and other information before modifying the existing units or adding new ones. When applications and plans are submitted, necessary water quality assessments will be made. The permit language addressed by NRDC was provided to alert the public to this situation; the applicant is already well aware of these requirements (see NPDES permit Part II.A.2, page II-1).

NRDC-25d(2)--Effluent Limitations: Standards of performance for new sources for the Steam Electric Power Generating Point Source Category do not establish a numerical effluent limitation for site runoff. Therefore, a "best management plan" approach was chosen for control of pollutants from these sources. A 50 mg/l total suspended solids concentration has been included as a design objective for operational control purposes. The EPA staff feels that the proposed

treatment ponds with filters will achieve this level of discharge if they are properly maintained.

NRDC-25d(3)--Low Volume Waste Limitations: The state certification limitation of 45 mg/l is applicable to the sewage treatment plant effluents only. Low volume waste limitations (40 CFR 423.15(c)) are applicable to this discharge.

NRDC-25d(4)--Metal Cleaning Wastes: The applicants are presently proposing to dispose of metal cleaning wastes off site. However, because of experiences at other nuclear power plants, onsite treatment may prove necessary. Therefore, limitations were included in the permit for contingency purposes. Volume of metal cleaning waste expected is on the order of 1 million gallons per batch or less. Cleanings would be expected very infrequently, on the order of once every 5 years or more.

NRDC-25d(5)--Effluent Monitoring: Monitoring data will be reviewed on a continuing basis for the CRBRP, as they are at other facilities, to ensure that frequency is adequate to assess compliance with effluent limitations. Even if monitoring requirements are reduced within the present permit period, such reductions would only be made after opportunity for public comment, pursuant to NPDES regulations, and reevaluation will be made at each reissuance. Increased monitoring frequency will be required if it is found to be necessary in the future. It should be noted that reactor criticality is not expected until 1990.

NRDC-25d(6)--Intake and Effluent Monitoring: The approach planned for monitoring plant intake and effluent, coupled with mixing zone evaluations required by proposed Permit Part III.D., will allow EPA and State of Tennessee staff members to ascertain instream compliance regardless of the actual river flow situation. Additionally, this approach allows quantification of pollutant additions made by the facility.

NRDC-25d(7)--Discharge of Priority Pollutants: Priority pollutants generally will not be used by or discharged from the facility. The exceptions are metals that are eroded or corroded from pipe surfaces and laboratory chemicals used by plant personnel. Additionally, concentration of ambient pollutants will occur as a result of the evaporation of water in the cooling towers and the use of demineralizers to treat process water. Based on data from operating nuclear power plants, discharge of significant quantities of priority pollutants is not expected. A period of 12 months has been proposed to allow stabilization of plant systems and operation before samples are collected. Part III.C of the permit requires monitoring of selected priority metals on a routine basis.

NRDC-25d(8)--Notification Requirement: The proposed requirement has been used at many other power plants and has proven effective. Additional requirements on chemicals that may not be discharged are provided on page I-7 for outfall serial number 011.

NRDC-25d(9)--State Certification: NRDC comments have been forwarded to the State of Tennessee for consideration.

12.3.6.9 Storm Drainage

DOE-G--Runoff Collection: The suggested change has been made to the text.

12.3.8 Power Transmission System

DOE-H and -I--Historic Sites: Comments regarding construction of the transmission system have been noted and appropriate changes have been made on page 3-20 of the FES supplement.

12.4 Environmental Impacts Due to Construction

12.4.2 Impacts on Land Use

NRDC-26a--Prime or Unique Land Use: The staff agrees with this comment and has modified the text to reflect the fact that the additional land to be committed will not affect any prime or unique land uses or special resources on the site because the additional resources affected are of comparable quality to those in the vicinity.

NRDC-26b--Indian Burial Mound: The comment was noted and the Indian Burial Mound has been deleted from Figure A4.1 of the FES supplement. The incomplete sentence noted in this comment has been corrected.

12.4.4 Ecological Impacts

12.4.4.1 Terrestrial

NRDC-27--Land Clearing: As stated in the Draft Supplement, the staff does not believe that the impacts to terrestrial resources resulting from construction activities at the Clinch River site will be environmentally significant. The staff has determined that those onsite terrestrial resources to be affected by construction activities do not possess unique or important flora or fauna and are comparable to resources in the vicinity of the plant.

The staff has reviewed a detailed plan for site construction activities (see DOE, June 1982, in the Reference section) and has concluded that the applicants' plans for erosion control, including redress and restoration, are acceptable (refer also Sections 4.4.2 and 4.6).

NRDC-33--Additional Dredging: See response in Section 12.4.4.2.

12.4.4.2 Aquatic

EPA-12--Erosion and Sediment Control Plan: Information has been added and the suggested change made.

EPA-13--Pink Mucket Pearly Mussel: The text has been revised to include the findings of the endangered species assessment.

NRDC-28--Endangered Aquatic Species: The text has been revised to indicate the FWS response to the endangered species assessment. The staff has reexamined its assessment based on the comments provided by NRDC and finds that the additional information will not alter the conclusions of the assessment.

NRDC-29--Striped Bass: The staffs of both the NRC and EPA have conducted an indepth assessment of the effect of CRBR operation on the striped bass that may

utilize the reach of the Clinch River in the vicinity of CRBR for a summer thermal refuge. Both the EPA and NRC staffs concluded that, during normal plant operation during normal river flows, impact to striped bass would not be likely; however, during extended periods of low flow, the possibility of some mortality to striped bass as a result of CRBR may exist.

The applicants are required by EPA to conduct studies to determine the potential for impact to this species during extended no-flow conditions in the river and simultaneous CRBR operation. Should these studies determine that there is a possibility of thermally related mortality to striped bass, the applicants have committed to operate CRBR in a way that precludes the possibility of significant thermally related losses attributable to plant operation.

NRDC comments that the NRC should prepare an impact statement supplement once the studies required by EPA are completed. If there is significant new information, the staff will assess the issue of striped bass and plant operation again when the applicants apply for an operating license for CRBR. It is anticipated that NRC and EPA would work cooperatively on any such review, but that EPA will propose and impose limits on plant operation such that striped bass will be protected.

In analyzing alternative sites, the staff assumed that the potential for striped bass losses at the CRBR site because of thermally induced mortality would be mitigated; therefore, the staff did not assume an adverse impact to striped bass at the CRBR site relative to alternative sites.

NRDC-31--Sauger: Section 4.6.2, item b, of the supplement recommends for inclusion in the construction permit a requirement that dredging, cofferdam construction, and fill deposition in the Clinch River not coincide with sauger spawning in the Clinch River unless the applicants provide evidence showing that these activities would not adversely affect this species.

NRDC-32--Barge-Unloading facility: The staff finds that construction of the barge-unloading facility will result in the destruction of some aquatic life, principally benthic and epibenthic organisms that presently inhabit the 1700-ft² of lake bottom that will be altered. The loss of this small area (≈ 0.04 acre) in relation to the habitable bottom available to organisms in Watts Bar Lake will not result in altering other aspects of the aquatic ecology in the vicinity of the proposed CRBR. Because construction is temporary, the staff reaffirms its position that recolonization of the area will rapidly occur once the bottom is stabilized. Studies by Cairnes et al. (1971) have documented the potential of temporarily disturbed substrates to be rapidly recolonized. Therefore, the relatively small area disturbed and the temporary nature of the disturbance eliminate this as a concern.

NRDC-33--Additional Dredging: The staff does not believe at this time that additional dredging will be necessary for the sole purpose of enabling barges to travel between the Clinch River facility and the barge port.

OCRE-7--Asiatic Clams: The possible effects of fouling of essential service water systems by Corbicula sp. are considered during the CRBR safety review. Use of chlorine in the cooling water systems for control of Asiatic clams has been considered and discussed. The proposed NPDES limitation of 0.14 mg/l can

be achieved by holdup of blowdown for a period of 1 to 2 hours or by dechlorination. TVA has wide experience with Asiatic clam control with chlorine at its existing coal- and nuclear-fueled power plants.

12.4.5 Impacts on the Community

OAG-1--Monitoring and Mitigation Process: See the response to TEN-1 below.

OAG-2--Effects of Mid-Project Shutdown: See the response to NRDC-129.

TEN-1--Monitoring and Mitigation: The NRC staff has discussed the possibility of establishing formal mechanisms for involving state and affected local governments in the mitigative process with the applicants. The process would entail official recognition of the participants, review of the output from the monitoring effort, the design of programs to mitigate adverse socioeconomic impacts, and routine reporting procedures. The applicants have agreed to discuss these matters with state and local jurisdictions, and have scheduled such meetings. The staff had considered imposing a formal mitigation process on the applicants as a requirement on the construction permit and license. However, because the applicants would be the only party to the mitigation process subject to NRC regulations, this approach was rejected.

12.4.5.3 Social Effects

OCRE-5--Psychological Stress: The NRC, in a Statement of Policy dated July 16, 1982, declared that the majority decision of the U.S Court of Appeals for the District of Columbia Circuit in Dane v. NRC, issued on May 4, 1982, stands for the proposition that an evaluation of environmental impacts under NEPA includes evaluation of "post-traumatic anxieties, accompanied by physical effects and caused by fears of recurring catastrophe," but only if each of three elements is present. First, the impacts must consist of "post-traumatic anxieties," as distinguished from mere dissatisfaction with agency proposals or policies. Second, the impacts must be accompanied by physical effects. Third, the "post-traumatic anxieties" must have been caused by "fears of recurring catastrophe."

In the Commission's view, the only nuclear plant accident that has occurred to date that is sufficiently serious to trigger consideration of psychological stress under NEPA is the Three Mile Island Unit 2 accident. Accordingly, only this accident can currently serve as a basis for raising NEPA, psychological stress issues (Statement of Policy, pp. 3-4).

Because there has been no accident since the issuance of the Statement of Policy as serious as the Three Mile Island Unit 2 accident that directly relates to the proposed CRBRP, the staff perceives no justification for assessment of psychological stress in connection with its environmental review-of-the CRBRP construction permit application.

12.4.5.6 Dust and Noise

DOE-J--Blasting Schedule: The last sentence in the sixth paragraph of this section has been changed to reflect more accurately the applicants' commitment on the scheduling of construction blasting activities, which would be scheduled during the first and second workshifts.

12.4.6 Measures and Controls To Limit Adverse Effects During Construction

12.4.6.1 Applicant Commitments

DOE-K--Construction Planning: The text has been changed to reflect this comment.

DOE-L--Historic Sites: Comments regarding offsite transmission line rights of way have been noted and selective changes have been made on page 4-28 (item 17) of the FES supplement.

12.5 Environmental Impacts of Plant Operation

12.5.3 Heat Dissipation System

12.5.3.1 Water Intake

NRDC-69--Entrainment: The staff considered that the worst case condition with respect to entrainment would be the riverine situation under the low flowrate of 1000 cfs. Under this flow condition, assuming a uniform distribution of planktonic organisms, 2.2% of the organisms flowing past the plant would be entrained. This calculated 2.2% maximum loss would not result in detectable impacts to any planktonic organism inhabiting the river. Natural variability in planktonic organisms would greatly exceed any CRBRP-induced impact.

12.5.3.2 Water Discharge

EPA-14--Permit Conditions: The suggested change has been made.

NRDC-65--Water Consumption: The staff has evaluated the effects of the thermal plume charges caused by the very slight increase in flowrate, and presented its conclusions in Section 5.3.2.1 of the Draft Supplement. The staff concluded that the thermal plume changes are not environmentally significant. See also Section 12.10.1.1 below.

NRDC-70--Thermal Plume: The conclusion that fish will be able to avoid potentially lethal temperatures is supported in Section 5.3.2.2 by several references. The staff conducted its assessment utilizing worst case conditions of extended low flow in the Clinch River, highest recorded ambient water temperature, and maximum heat rejection from the plant. It is highly unlikely that a combination of values producing conditions worse than those in this "worst case" would occur with a frequency sufficient to cause significant impact to any native aquatic species inhabiting the Clinch River.

Reports and assessment relative to proposed NPDES permit conditions III.D, M, N, and O will provide data for assessment of impacts of the CRBR project on striped bass and other aquatic species. Aquatic preoperation and operational monitoring programs will be conducted. EPA and the State of Tennessee will be principally responsible for the review of these data and for assessing the non-radiological impacts associated with plant construction and operation; however, the NRC and the FWS will provide assistance in this review (see Part III-P, page III-5).

12.5.3.4 Endangered Species

NRDC-28--Endangered Aquatic Species: See response in Section 12.4.4.2.

12.5.7 Radiological Impacts

12.5.7.2 Radiological Impact on Man

DOE-M--Occupational Dose Estimate: The staff agrees that an estimate of 1000 person-rem per year for CRBR during normal operation is conservative. Available data indicate that occupational doses at sodium-cooled reactors are likely to be significantly less than current doses at light-water-cooled reactors. The staff used a conservative value because so few occupational dose data are available on large sodium-cooled reactors.

EPA 19--Basis for Radiological Estimates: Radiological estimates for CRBRP and its environs for the impacts of routine operations and effluents are based on a plutonium composition (roughly 1% Pu-238, 72% Pu-239, 18% Pu-240, 6% Pu-241, 2% Pu-242) which is expected to be bounding radiologically with respect both to the proposed initial core loading and any core content expected during the life of the plant. The effluents are also based on operation with 0.5% failed fuel, which is considered a conservative assumption. Therefore, the staff judges that the estimated radioactive effluents and their impacts reasonably bound those from the routine operation of CRBRP over its lifetime.

LRC-2, SS-3--"Reasonable" Dose: As a conservative and prudent assumption, it has been assumed that no amount of radiation is safe. For more than four decades, the effect of radiation on humans and animals has been thoroughly studied. Numerous major biological research programs have been well documented and may be found in the open literature. The United States has been the forerunner in radiation research, but many other countries also have pursued similar programs and have contributed substantially to current knowledge. While the relationship between ionizing radiation dose and biological effects among humans is not precisely known for all levels of radiation (e.g., background radiation), the variations in exposure to natural background radiation are comparable to the doses being evaluated.

Data from studies of animals and humans are reviewed continuously by teams of scientific experts who evaluate radiological information and provide recommendations. In the United States, the principal expertise in radiological matters lies with the National Council on Radiological Protection and Measurements and the National Academy of Sciences/National Research Council (NAS/NRC). Federal agencies also retain expertise in the radiologic disciplines in order to fulfill their responsibilities; these agencies, however, rely heavily on recommendations of the previously mentioned advisory organizations. Other countries have national advisory organizations similar to those of the United States. There are also cooperative international organizations that evaluate data from all sources and present recommendations and conclusions; for example, the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) and the International Commission on Radiological Protection (ICRP). In summary, not only have the radiological data been ascertained by the world's outstanding biologists and epidemiologists, but their data have been evaluated independently by their peers.

In lieu of precise knowledge of the relationship between low-level radiation and biological effects, a linear nonthreshold extrapolation from high radiation levels to the lower levels is assumed for radiation protection purposes. This means that it is assumed that any dose of radiation, no matter how low, may be harmful.

NRDC-4--Radiological Impacts From Drinking Water: This comment contains a statement that "the staff should consider and discuss how CRBRP radioactive discharges...might affect...the public that uses the Clinch River for its drinking water." The staff did consider and discuss those impacts in the Draft Supplement. Page 5-18 of the Draft Supplement states: "population dose estimates are based on a projected 2010 population of 910,000 persons living within 50 miles of the plant and 29,000 receiving drinking water from Clinch River and its tributaries." Dose estimates from water ingestion by the population within 50 miles of CRBRP, as well as the U.S. population, are given in Table A5.5. Dose estimates from water ingestion by a maximally exposed individual to liquid radioactive effluents are given in Table A5.2.

NRDC-6 and -34--Radiological Impacts From Dredging Sediment for Construction of CRBR Barge Unloading Facility: This comment states: "NRDC believes that the potential exists for relatively high doses resulting from the dredging associated with the Clinch River Breeder Reactor." As support, the NRDC states: "a maximum dose measurement over stream channelization spoil deposits at Jones and Grubb Islands...was 455 mrem, including background," and references ORNL-3721, page 86.

The staff has estimated the radiological impacts from the proposed dredging of sediment in the vicinity of the Clinch River Breeder Reactor barge unloading facility (on the basis of ER Sec 2.8.3, 4.1.1.3, and 4.1.2.3, and the Site Preparation Activities Report Sec 3.2, 3.3, and 4.1.2). Conservative estimates of the doses to a maximally exposed individual and to the general population are given below. The doses to the maximally exposed individual are based on the individual receiving all drinking water from the nearest downstream drinking water intake. The dose to the total body and the dose to any body organ from ingesting radionuclides in drinking water would be less than 0.01 mrem. The doses from ingesting fish containing these radionuclides would be about the same order of magnitude as the doses from ingesting water. These doses are very small fractions of the annual dose (about 100 mrems) from exposure to natural background radiation. The dose to the population within 50 miles of the plant is conservatively estimated to be about 0.3 person-rem to the total body. This dose is a very small fraction of the annual population dose (about 90,000 person-rems) from exposure to natural background radiation.

In regard to the NRDC's dose estimate of 455 mrems, it should be noted that page 85 of ORNL-3721 states: "Almost without exception the direct radiation measurements made above the spoil material were lower than the measurements made the same day over the river bank or pasture areas which were not affected by the spoil deposits." Page 86 of ORNL-3721 states: "The highest measurement made over the soil deposits (0.052 mr/hr) would produce a total dose of only 455 mrems per year, including background. For comparison, at least three measurements made over undisturbed areas of the island indicated a dose from fallout that was this great or greater."

NRDC-35 and -36--Radiological Impacts From Exposure to Liquid Effluents From CRBRP: The main point of NRDC-35 is that dose calculations (in Table A5.2) should be updated using the dose conversion methodology from publications subsequent to ICRP II (see e.g., NUREG/CR-0150). The staff is aware of the dose conversion factors in other publications, such as NUREG/CR-0150 and ICRP Publication 30; however, the staff notes that these other publications contain dose conversion factors for only one age group--adults. The models described in Regulatory Guide 1.109 contain a number of parameters, including dose conversion factors, for four different age groups (i.e., infants, children, teenagers, and adults). Because the estimated doses (less than 0.1 mrem/yr, Table A5.2) are very small fractions of the annual dose from exposure to natural background radiation (about 0.1 rem/yr), use of dose conversion factors from the other reports would not change the basic conclusion of the analysis.

The main point of NRDC-36 is that the "dose(s) due to fish ingestion in Table A5.2 are understated due to the failure to consider resuspension of radioactivity in the sediments associated with barge traffic and dredging...." However, NRDC-36 does not reference any material that indicates that doses have been significantly underestimated. The staff's models (see Regulatory Guide 1.109) do not explicitly take into account resuspension of radioactivity in sediments. However, it is the staff's position that conservatism in other parameters that are used in the dose calculations would more than offset this potential lack of conservatism in a seemingly minor pathway. It should be noted that the dose estimates in Table A5.2 are in mrem/yr, not "milligram per year," as stated in NRDC-36.

NRDC-37--Compliance With 10 CFR 20: This comment states "the staff evaluates the radiation exposure from routine CRBRP operations but does not calculate the total radioactive doses when these are added to doses from activities at the Oak Ridge National Laboratory, the Y-12 Plant, the Oak Ridge Gaseous Diffusion Plant, and the proposed developmental reprocessing plant,..." The comment implies that the total dose to an offsite individual (i.e., the sum of the doses to a single individual from exposure to radiation associated with CRBRP, ORNL, Y-12, ORGDP, and a proposed reprocessing plant) will exceed the limits of 10 CFR 20. Based on the staff's estimates of doses to an offsite individual maximally exposed to radiation associated with CRBRP (see Section 5.7 of the supplement) and on DOE's estimates of doses from exposure to radiation associated with ORNL, Y-12, and ORGDP (see ER Section 2.8), the staff has concluded that it is extremely unlikely that the total dose to an individual will exceed the limits of 10 CFR 20. (Note: Site-specific information would be needed before doses to a maximally exposed individual from radiation associated with a proposed reprocessing plant could be evaluated.)

NRDC-38--Gastrointestinal Absorption Factor For Pu: This comment states: "the current methodology used for calculation of the plutonium dose contributions associated with liquid effluents are understated by several orders of magnitude for the water ingestion pathway where chlorination treatment is utilized in water treatment plants." As support for this statement, the NRDC refers to an article by R. P. Larsen and R. D. Oldham, "Plutonium in Drinking Water: Effects of Chlorination on Its Maximum Permissible Concentration," Science, 201, pp. 1008-1009. The staff has reviewed the referenced article, as well as its own dose estimates, and notes the following. First, the estimated doses to the maximally exposed individual drinking water (less than 0.01 mrem, see

Table A5.2) are very small fractions of the annual dose from exposure to natural background radiation. Second, the estimated doses from exposure to the relatively small quantities of plutonium in drinking water are less than 1% of the total doses from ingesting water. Consequently, even assuming that the gastrointestinal transfer factor for plutonium were increased by three orders of magnitude, the doses to the maximally exposed individual from drinking water would be a very small fraction of the annual dose from exposure to natural background radiation (see Table A5.2).

NRDC-39--Risks From Occupational Exposure: See responses to OCRE-09, OCRE-10, SS-3, and LRC-2.

NRDC-39a--Radioactive Materials, Doses: The text in Sections 5.7.2.6, 5.7.2.7, and 5.7.2.8 has been revised as appropriate.

NRDC-39b, 42, and 91; DHHS-5--Radiological Environmental Monitoring: These comments raise two main points: (1) "the staff has not demonstrated that this program will be sufficient to enable the applicants...to distinguish between CRBR radiological effluents and baseline effluent levels" and (2) the program should be described in more detail in the supplement. In regard to the first point, it should be noted that the results of the radiological environmental monitoring are intended to supplement the results of the radiological effluent monitoring by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and modeling of the environmental exposure pathways. The primary monitoring of gaseous and liquid radioactive effluents from the vents and discharge points of the plant during normal operations is performed by the effluent monitors installed in the plant to measure directly the radioactive content of the effluent stream.

In regard to the second point, the radiological environmental monitoring program is not described in more detail in the environmental impact statement because the impacts from an environmental monitoring program are negligible. For more detailed information, see ER Section 6.2, and the response to comment LGW-1. See also Section 12.11.6.7.

OCRE 9 and 10--Radiation Hazards: The commentor references two articles in Science News that indicate that the risks from some types of low-level radiation may be higher than previously estimated. The first article ("A-Bomb Survivor Risks are Revised Upward," Science News, June 19, 1982) is a summary of a recent publication by Dr. Alice Stewart. The staff notes that there is a substantial body of literature, in addition to the studies on atomic bomb survivors, on the risks of radiation exposure at dose levels much higher than those estimated in the Draft Supplement to the FES. Some of the other major groups studied include (1) radium dial painters, (2) early radiologists and dentists, (3) uranium miners, (4) ankylosing spondylitis patients, (5) children irradiated for thymus enlargement, (6) tinea capitis patients, (7) patients receiving breast irradiation, and (8) children whose mothers were irradiated during pregnancy. The staff used this data base (from the BEIR Report) in making conservative estimates of health effects.

The second article ("Radiation: When Less Is Not Better," Science News, July 17, 1982) is a summary of a recent publication by C. K. Hill et al.

("Fission Spectrum Neutrons at Reduced Dose Rates Enhance Neoplastic Transformation," C. K. Hill, F. M. Buonaguro, C. P. Myers, A. Han, and M. M. Elkind, in Nature, July 1, 1982). The staff has made a cursory review of the publication by Hill et al. in regard to its impact on the analysis in the Draft Supplement and notes the following: (1) the article does not state that risks from occupational exposure to neutrons are greater than previously thought, but rather that the risks may be greater; (2) while the NCRP's Scientific Committee 40 is presently reviewing the basis for estimating risks from exposure to neutrons (and presumably articles similar to that by Hill et al. will be included in the review), a final report has not been published; (3) the staff does not anticipate that exposure to neutrons will be a large part of the annual plant worker population dose at CRBRP; and (4) the annual plant worker population dose estimate in the Draft Supplement was a conservative estimate of the dose (see response to DOE-M above). In summary, the staff thinks that, pending new information, the analysis of the risks from occupational exposure is appropriate.

SRIC-2--Potential Impacts From Transuranics: Relatively small quantities of transuranics will be released from CRBRP and some fuel cycle facilities. The staff has estimated doses from exposures to radiation associated with CRBRP and the fuel cycle (see Section 5.7.2 and Appendix D). The estimated doses from exposure to transuranics released from these facilities are very small fractions of the estimated doses from exposure to all of the radioactive effluents released from these facilities.

SRIC-3--Changes in Dispersion and Dilution Factors: This comment raises three questions: (1) How were the doses in Tables A5.2 and A5.3 estimated?; (2) Why was the site boundary changed from 0.4 miles south-southwest in the FES to 0.44 miles northwest in the supplement?; and (3) Why was the dilution factor reduced from a factor of 670 in the FES to 67 in the supplement? In response to the first question, page 5-11 of the Draft Supplement states that dose estimates were made using the models described in Regulatory Guide 1.109. The staff included the pertinent references in the supplement, rather than the detailed calculations, because the primary emphasis in the supplement should be on describing the potential impacts, rather than the detailed calculations. Copies of Regulatory Guides can be obtained by writing to the U.S. Nuclear Regulatory Commission, Washington, DC 20555, Attn: Director, Division of Technical Information and Document Control.

In response to the second question, the staff evaluated the doses from exposure to airborne radioactive effluents for the "nearest" site boundary. "Nearest" refers to that type of location where the highest offsite radiation dose is expected to occur from all appropriate pathways. The "nearest" site boundary changed because a new data base was used to estimate meteorological dispersion factors (see also Section 2.6 of the supplement).

In response to the last question, the dilution factor of 67 that was used in the supplement is a worst case dilution factor. The dilution factor of 67 is based on the "worst case" centerline dilution at the Oak Ridge intake using conservative model of dilution described in NUREG-0868, "A Collection of Mathematical Models for Dispersion in Surface Water and Groundwater."

SRIC-5--Cumulative and Potentially Synergistic Effects: This comment raises two points: (1) "the cumulative and potentially synergistic effects of other

activities in the nearby area" should be discussed; and (2) the potential radiological impacts from dredging should be discussed. In response to the first point, it should be noted that the estimated doses from exposures to radioactive effluents from CRBRP are very small fractions of the dose from exposure to natural background radiation in the CRBRP area. The staff is not aware of any studies that have established that there are synergistic effects of exposures to radiation and chemicals at radiation dose levels as low as those estimated in the supplement. In lieu of precise knowledge of the relationship between low-level radiation and biological effects, a linear nonthreshold extrapolation from high radiation levels to the lower levels has been assured in the supplement (see response to LRC-2 and SS-3 in this section above). In response to the second point, see response to NRDC-34 for a discussion of potential impacts from dredging.

SS-1--Cumulative Dose Effects: The Draft Supplement to the FES contains estimates of the annual doses to offsite individuals and populations from exposure to radioactive effluents from CRBRP (e.g., see Tables A5.2, A5.3, and A5.5). The estimated annual doses to offsite individuals are very small fractions of the annual dose from exposure to natural background radiation. If the annual dose of radioactive effluents from CRBRP to the maximally exposed offsite individual were added to the annual dose from exposure to natural background radiation in the Oak Ridge, Tennessee area, the total annual dose would be well within the range of doses due to background radiation in the U.S. (See also response to SS-3 below for a discussion of potential health impacts from exposure to ionizing radiation.)

SS-2--Dilution Factors: In the Draft Supplement to the FES, the staff has estimated the doses to a maximally exposed offsite individual from routine releases of radioactive effluents from CRBRP and the dose to the population. In estimating the doses to the maximally exposed individual, the staff did not assume that the liquid radioactive effluents were fully diluted by the full river flow or that the gaseous radioactive effluents were uniformly dispersed in the atmosphere. The aquatic dilution factors and the meteorological dispersion factors that were used in estimating doses to the maximally exposed individual are conservatively realistic factors (i.e., it is likely that the actual dose will be less than the estimated dose).

In regard to the assumption that releases will occur during average meteorological conditions, it should be noted that gaseous radioactive wastes are processed continuously, and small quantities (as compared to the untreated wastes) of these gaseous wastes are released continuously as effluents to the environment. Therefore, in estimating doses from exposures to routine releases of radioactivity to the atmosphere, the releases are assumed to occur during every hour of the year. The meteorological conditions during each hour of a year, including stormy weather and temperature inversion, are used to make the diffusion assessment.

It is correct that the most limiting meteorological diffusion condition is the temperature inversion condition. The staff analysis utilizes the joint frequency occurrence of stability condition (including inversions), wind speed, and wind direction for the entire year to estimate the expected annual average diffusion conditions. In performing the dose assessment, the atmospheric diffusion model used by the staff ensures that the peak potential radioactivity concentrations

occur at the ground at the nearest offsite location. (See also responses to EPA, A-22 in Section 11.5.29 of the FES.)

WAL-2--Mill Tailings: See response to WAL-2 in Section 12.12.D.2.

WAL-3--Potential Health Impacts From Exposure to Radon and Its Daughters: See response to WAL-2 in 12.12.D.2 for a discussion of the quantities of radon-222 estimated to be released from the fuel cycle.

12.5.7.3 Evaluation of Radiological Impact to the General Public

NRDC-39a--Fuel Cycle Impacts: The text in Section 5.7.3 has been revised to reflect NRDC's comments on Appendix D as appropriate (see also the response to NRDC 93-102 in Sections 12.12.D.1 and 12.12.D.2).

12.5.8 Conclusion

NRDC-39a--Conclusions Regarding Fuel Cycle Impacts: The text in Section 5.7.3 has been revised to reflect NRDC's comments on Appendix D as appropriate (see also NRDC 93-102).

12.6 Environmental Measurement and Reporting Programs

12.6.1 Preoperational

12.6.1.3 Meteorological

NRDC-40--Meteorological Measurements: For a preliminary review, such as a construction permit review, an applicant is required to provide at least 1 year of representative meteorological data. This data base will be augmented by additional information for the OL review. The applicants have reinstrumented the 110-m tower, and this tower was returned to service in April 1982.

All of the meteorological towers installed by the applicants have been located on site, generally to the south of the main reactor complex. This area is considered to provide tower locations with exposures most representative of the plant site. The locations of other meteorological measurements such as those at ORGDP, ORNL, and Knoxville are irrelevant with respect to the location of the onsite meteorological tower.

The discussion of the methodology and assumptions in this section pertains only to the assessment of impacts of routine releases. Assessments of the consequences of design-basis accidents will be presented in the SER.

Releases are assumed to be at ground level because this will result in the highest ground-level concentrations and will therefore result in conservative estimates of dose consequences. The staff has used a straight-line trajectory model modified to include consideration of recirculation.

Other models are available, but the modified straight-line trajectory model should provide conservative estimates of atmospheric dispersion conditions for dose consequence assessments. Potential routine releases were reviewed by the staff, and it was found that these gaseous radioactive wastes are processed

continuously, and small quantities of these gaseous wastes are released continuously as effluents to the environment.

12.6.1.4 Ecological

EPA-12--Erosion and Sediment Control Plan: See Section 12.4.4.2.

EPA-15--Figure A6.3: The correction has been made.

NRDC-41--Aquatic: The staff, in describing the baseline aquatic biology of the Clinch River in the vicinity of the CRBR site, utilized studies conducted by Exxon Nuclear Corporation (1976) and Oak Ridge (1981) in addition to information provided by the applicants. The use of information from all three studies provides an adequate baseline.

The staff emphasizes the use of good construction practices to minimize adverse impact to aquatic biota rather than studies designed to measure impact. Information on the extent and magnitude of construction-related impacts to aquatic biota are necessarily after the fact. Furthermore, because construction is a continuing process of some specified duration, this information is generally of limited value in reversing any perceived impacts. Therefore, the staff prefers that applicants concentrate on eliminating any potential construction-related impacts to aquatic biota rather than attempting to measure such impacts. Consequently, the importance of an up-to-date preconstruction effects baseline is of limited value.

The Erosion and Sediment Control Plan has been approved by EPA and the State of Tennessee and a copy has been forwarded to NRDC. Compliance with the plan will ensure that any impact on aquatic organisms is minimal. The NRC staff is of the opinion that construction effects aquatic monitoring in the Clinch River is not necessary.

12.6.1.6 Socioeconomic

DOE-N--Worker Surveys: The suggested modifications on the worker survey are reasonable and are reflected in the revised text.

12.6.2 Operational

12.6.2.2 Radiological Monitoring

LGW-1--Radwaste Management: This comment contains several general statements that reflect some misunderstandings regarding: (1) the concentrations of radionuclides in sediments of the Clinch River in the vicinity of the plant; (2) the impact of dredging operations in the vicinity of the plant; and (3) the need for chromosome aberration studies and bioassay toxicity studies in the general population. Therefore, the staff has attempted to provide more detail on some of these concerns.

In regard to the first statement, the commentor refers to the "high-level ionizing materials currently in sediments of the Clinch River," after referring to "management of the radwastes (low-intermediate and high level) to the environment" in the preceding sentence. Measured concentrations of radionuclides in the Clinch River sediment are presented in the Environmental Report (see

Tables 2.8-7 and 2.8-8, and Figures 2.8-5, 2.8-6, and 2.8-7). The concentrations of these radionuclides in the sediment are many orders of magnitude lower than the concentrations of radionuclides in high level waste, and the staff would not characterize these concentrations as "high-level ionizing materials."

In regard to second statement regarding the impact of dredging operations, see the response to NRDC-34 in Section 12.5.7.2.

Regarding the last statement, it should be noted that the NRC requires two types of radiological monitoring at nuclear power reactors to ensure that radioactive effluents are within acceptable limits: (1) radiological effluent monitoring and (2) radiological environmental monitoring. Radiological effluent monitors are required to monitor and control, as applicable, the releases of radioactive materials in liquid and gaseous effluents during actual or potential releases. The radiological effluent monitors operate continuously. In addition, NRC requires that the licensee/operator of a nuclear power reactor conduct radiological environmental monitoring to confirm that measured releases of radioactivity (i.e., radiological effluent monitoring) from the plant do not result in unanticipated buildups in the environment.

The requirements for an acceptable radiological environmental monitoring program for nuclear power reactors are in the NRC Radiological Branch Technical Position (Revision 1, November 1979), "An Acceptable Radiological Environmental Monitoring Program," copies of which are available from the NRC Radiological Assessment Branch). The Branch Technical Position was developed by experts in the field of radiological environmental monitoring. The staff does not require chromosome aberration studies or bioassay toxicity studies for several reasons. First, based upon the staff's estimate of doses to the maximally exposed individuals (see Tables A5.2 and A5.3), the staff does not anticipate a significant buildup of radioactivity in the environment due to normal operation of CRBRP. Second, hundreds of reactor-years of environmental monitoring experienced at nuclear power plants have shown that the concentrations of radioactive materials in environmental samples are at or very near background levels due to natural sources and previous atmospheric weapons tests.

12.7 Environmental Impact of Postulated Accidents

12.7.1 Plant Accidents Involving Radioactive Materials

12.7.1.1 Classification of Accidents

NRDC-43--Dose Calculations: The values of the bone doses reported in Table 7.2 of the FES range from 0.003 rem to 1.2 rems. These doses were calculated by the use of the dose conversion factors of ICRP-2. A comparison of the bone dose conversion factors of ICRP-2 with the ICRP-30 conversion factors for the bone surface indicates that, as a maximum, the bone surface dose values might increase by a factor of about 3 above those reported for bone. A footnote has been added giving the difference in values between bone and bone surface doses. A three-fold increase in the values of bone surface doses over the bone doses reported in the 1977 FES Table 7.2 would not change the conclusions regarding the risks to the public due to the accident doses listed in the FES Table 7.2. The objective of the presentation in the FES of the realistic doses attributable to design-basis accidents is to provide a perspective of risks to the public and to the environment, should such events occur, and the engineered safety

features function as expected. The realistic doses presented in the FES would be considerably smaller than the dose estimates conservatively made for compliance with the requirements of 10 CFR 100.

The estimated dose at the site boundary in 2 hours and the estimated dose to the population within 50 mi for the duration of the accident presented in Table 7.2 of the FES provide good measures of the realistic radiological environmental impacts of accidents, meeting the information needs of an environmental impact statement; on the other hand, 10 CFR 100 provides for conservative calculations of impacts of specific radioactive releases as an aid in determining the suitability of the designs of the plant mitigation systems in conjunction with the site characteristics. The conservative radiological dose calculations required by 10 CFR 100 were performed and reported in NUREG-0786 (the Site Suitability Report, which is a revision of a March 4, 1977 report).

NRDC-113--Design-Basis Accidents: In comparing the design-basis accidents doses presented in FES Table 7.2 with those presented in LWR FESs, the staff is not attempting to equate the CRBRP accidents with the LWR accidents. The intent of the comparison is, rather, to show that the accidents at CRBRP have dose consequences comparable to those for light water reactors.

The staff's SER for CRBRP will show that the design basis accidents postulated for CRBRP will satisfy the dose guidelines of 10 CFR 100, taking into account the pessimistic assumptions regarding source terms and atmospheric dispersion factors (χ/Q_s). Evaluation of the same CRBRP accidents using realistic assumptions of source terms and atmospheric dispersion factors would result in significantly lower doses than the 10 CFR 100 dose guidelines, as has been the case for LWRs. Therefore, the expectation of the comparability of the design-basis accident doses for CRBRP and LWRs arises not from the consideration of the similarities of the nature of the design-basis accidents, but from the consideration that both types of plants must meet the dose guidelines of 10 CFR 100 (based on pessimistic assumptions) for safety evaluation purposes, and present realistic dose calculations of the design basis accidents in the environmental statements. Therefore, any differences in the CRBRP and LWR accidents would not significantly affect the conclusions that "the recorded values (of doses) appear to the staff to be reasonable."

12.7.1.2 Comparison of Probabilities of Class 9 Events: LWRs vs. CRBRP

MIL-3--Criticality During Accidents: The staff has not ignored the probability of criticality in the Class 9 accidents consideration. In the CDA (Class 9 events) class of accidents, criticality is considered in both the overpower sequence (via failure of shutdown system operation) and in the undercooling sequences (via core melt and rearrangement). In Section J.1.2(1) the staff has discussed the probability of the failure of the two independent shutdown systems. Each shutdown system consists of three independent electrical actuation channels of diverse logic and diverse components. The systems employ diverse mechanical designs. Thus, the staff has judged that there are sufficient inherent redundancies, diversities, and independencies in the overall shutdown systems that the probability of the unavailability of shutdown systems (to end the criticality) is expected to be less than 10^{-5} per demand.

In assessing the response of the primary system, the staff has again considered in primary system failure Categories III and IV, the possibility of recriticality with the consequence that the primary system seals fail open by excessive mechanical and thermal loads (primary system failure Category IV). A large release to the containment of noble gases, volatile material, and solid fission products and core plutonium is assumed to occur immediately. The probability of such accidents is discussed further in the responses to NRDC-118, NRDC-126, and OCRE-3.

12.7.1.3 Consequences of Class 9 Accidents

CWE-2--Radiological Exposure of Biota: Evaluations of the impacts on biota of intense radiation sources of the kind which resulted from numerous atomic and nuclear tests have shown that although numerous organisms had been killed by the blasts, the impacted sites became repopulated by migration from the unaffected zones, and no permanent losses have occurred. Except where unique species exist, the scientific consensus is that no irreparable harm will occur; repopulation will be relatively rapid soon after an accident (NUREG-0440). Considering the likelihood and the consequences of the postulated severe accidents of CRBRP, the impacts on biota are judged to be small and the risks not significant.

WAL-1--Accident Experience: The accidents at EBR-I, SL-I, Fermi-1, and TMI-2 occurred over a span of several decades. The accident experience in small experimental and test reactors such as EBR-I and SL-I is not indicative of the safety of licensed commercial reactors, and it is not a good indicator of safety differences between LMFBRs and LWRs. Although there are significant physical differences between LMFBRs and LWRs, they share a common base of nuclear reactor and power plant safety development. Such safety developments are incorporated in both the CRBRP and LWRs as appropriate. The lessons learned from the Fermi 1 and TMI-2 accidents are being factored into the CRBRP safety design to provide assurance that similar accidents will not occur at CRBR. This common base of safety development, augmented with generic LMFBR safety research results and safety research and development specific to CRBRP, is being applied in the design and licensing of CRBRP with the goal of ensuring that the risks from CRBRP will be comparable to, if not lower than, those from current LWRs.

12.7.2 Transportation Accidents Involving Radioactive Material

NRDC-44--Fuel Shipments: For reasons set forth in the second and third full paragraphs on page 7-4 of the Draft Supplement, the analyses and conclusions of previous environmental assessments of serious transportation accidents involving irradiated LWR fuels (WASH-1238, NUREG-0002) were shown to be applicable to CRBR fuels. Therefore, the staff found no need to repeat or duplicate the previous calculations.

The radiological consequences from a serious transportation accident with spent CRBR fuel could be larger than similar occurrences with LWR fuels, but not so much as to negate the conclusions of the analysis. Of the volatile isotopes presented in Table D-7 of the Draft Supplement, only iodine-131 has a half-life short enough to be of consequence in this regard. In NUREG-0002, the iodine-131 concentration was stated to be 2.0 Ci/MT for 150-day-cooled spent LWR fuel. For that assessment of LWR spent-fuel transportation, the staff projected that the shipment of such fuel would contain about 4.0 MTHM and would thus contain

8.0 Ci of iodine-131. From Table D.7, the iodine-131 concentration in CRBR spent fuel is estimated by the staff to be 39 Ci/year, amount to 2.8 Ci/shipment for 150-day-cooled fuel. For 100-day-cooled fuel, the corresponding amount of iodine-131 would be about 240 Ci/shipment. Thus, the amount of iodine-131 is about 25 times as much for a CRBR shipment as for that considered in NUREG-0002. The upper bound calculated dose to the thyroid of a typical member of an emergency crew responding to a low-probability, serious, transportation accident, as calculated in NUREG-0002, was 0.1 rem. For a similar low-probability, serious, transportation accident involving CRBR spent fuel, the calculated upper bound dose to the thyroid would be 2.5 rems. Although 2.5 rems is greater than was calculated in NUREG-0002, it is less than the dose (5 rems) established by EPA as the projected dose to individuals in the population that warrants protective actions such as controlling access, seeking shelter, or evacuation.

The staff has limited its evaluation to those alternatives reasonably covered by the applicants' submittals. The use of sodium as a cask coolant previously proposed by DOE has been excluded from the existing ER as a result of NRC questions and so was excluded from the staff analysis. The Draft Supplement explicitly applies only to casks not using sodium as coolant (see page 7-4). In the event that the applicants decide to consider sodium cooling of shipping casks at a later date, this would have to be submitted to NRC to establish compliance with 10 CFR 71 guidelines and dose limits.

12.7.3 Safeguards Considerations

CEC-2--Nonproliferation Diversion and Sabotage: The California Energy Commission (CEC) contends that the LMFBR fuel cycle represents a greater proliferation risk than some other fuel cycles, quoting the 1977 Office of Technology Assessment report "Nuclear Proliferation and Safeguards" as evidence. The comment also implies that construction of the CRBRP will lead, presumably indirectly and over a long time, to the acquisition by other nations of LMFBR fuel cycle technologies.

The staff has not evaluated the relative proliferation resistance of the various fuel cycles or the likelihood that development of the CRBRP will lead eventually to the further proliferation of nuclear weapons. It should be noted that such issues were beyond the scope of the staff's assessments, but they were evaluated in the International Nuclear Fuel Cycle Evaluation (INFCE) effort. For an assessment of the relative proliferation resistance of fuel cycles, the results of INFCE should be consulted. In addition several foreign nations have independent LMFBR programs, and the Carter Administration policy of curtailing the U.S. LMFBR program in hopes of influencing foreign activities does not appear to have worked. The purpose of the staff's review was not to evaluate U.S. nonproliferation policy but to determine if DOE's proposals for safeguarding the CRBR fuel cycle are adequate. Because the CRBRP and all of its supporting facilities would be located in the United States, the review was limited to consideration of subnational theft, diversion, and sabotage.

The CEC questions the staff's conclusion that the theft, diversion, and sabotage risks associated with the CRBR fuel cycle would not be significantly greater than the risks associated with currently operating facilities. The CEC observes that the CRBR fuel cycle would handle larger quantities of plutonium than other fuel cycles, making the former an exceptionally attractive target.

It is true that the CRBR fuel cycle would handle large quantities (thousands of kilograms) of plutonium. It is also true that most currently operating facilities associated with the commercial nuclear power industry do not handle similar quantities of plutonium or other strategic special nuclear material (SSNM). There are, however, many facilities connected with various military nuclear programs and other programs not directly related to nuclear power, some of them NRC-licensed, that handle significant quantities of SSNM. The staff's conclusion that the risks associated with the CRBR fuel cycle would not exceed those associated with currently operating plants was based in large part on comparison with these other facilities.

The CEC contends that the CRBR will be an attractive sabotage target compared to existing facilities. The reasons cited are (1) that the "CRBR is a program designed to advance the state of the art of knowledge about breeder reactors" and (2) "the most dangerous nature of plutonium (both because of its chemical nature and its weapons potential)."

The staff finds no basis for the CEC claim that the demonstration function of the CRBR would make it a more attractive sabotage target. Accordingly, the staff cannot respond to this comment. The staff also disagrees with the second reason offered by the CEC, that the CRBR would be a more attractive sabotage target because it is fueled with plutonium. Appendix J discusses the contributions to health consequences of various radionuclides. Increasing the plutonium content of the core would not significantly increase the health consequences of successful sabotage. Also, the fact that plutonium can be used to make nuclear weapons will not increase the sabotage attractiveness of the CRBRP. The CEC is confusing the issues of sabotage and theft.

The comment references the rocket attack on the breeder reactor under construction in France as proof that the risk of sabotage of the CRBR or its fuel in transit is greater than projected by the supplement. The staff has assessed the French incident and has concluded that the weapons used in the attack do not exceed the NRC's design-basis threat for sabotage.

The CEC states that there is evidence to suggest that safeguards at nuclear power plants are not able to protect against the NRC design-basis threat and that numerous incidents of sabotage of U.S. and foreign nuclear reactors are well documented.

The NRC keeps careful records of sabotage incidents at licensed nuclear reactors. There have been no sabotage incidents that were intended to or have in any way endangered the public health and safety. The staff tracks events at foreign power reactors, and in all the foreign events reviewed there have not been any occurrences that would suggest that U.S. nuclear power plants are not sufficiently protected.

The NRC has not received the DOE site vulnerability assessment reports and has received no official information concerning the recently publicized tests.

NRDC-45--Safeguards: No changes to Section 7.3 were necessary.

12.8 Need for the Proposed Facility

12.8.1 Historical Background of the LMFBR Program

ISA-1--Electricity Shortages: The comment incorrectly attributes to the NRC staff several phases concerning consequences of early CRBRP development that are quotations from the applicants' supplement to ERDA-1535. See also response to OCRE-1.

OCRE-1 and -2 and SA-2--Need for CRBR: The need or justification for the CRBR is established by the ERDA (DOE) impact statement and Congressional intent. The commentor is referred to pp. 28-48 and Appendix F of "U.S. Department of Energy, Draft Environmental Impact Statement--Liquid Metal Fast Breeder Reactor Program (Supplement to ERDA 1535)," December 1981.

12.8.3 The Ability of the CRBRP To Meet Its Objectives

MIL-2b--Electric Power Production: The programmatic objectives of the CRBRP do not require that a specific amount of electricity be generated. As stated in Section 8.3, confidence in the U.S. capability is based on continuing EBR-II performance and the recent startup and operation of FFTF at full power. Despite difficulties foreign breeder reactors have experienced, they have also achieved considered success.

NRDC-13--Breeding Ratio: Breeding ratio is calculated to be 1.29 with initial core, 1.24 with equilibrium core. Further refinement of uncertainties in the calculation is unnecessary at this time, as discussed on page 8-8 of the 1977 FES.

12.8.4 Technical Alternatives to the CRBRP

CEC-1--Alternatives: At the time the FES was written in 1976, the staff considered it necessary to be fairly cautious about concluding that the CRBR technology was adequately proven in comparison to the other alternatives considered. Experience accumulated since then, however, has been generally favorable and serves to reduce some of the uncertainties associated with the staff's original conclusions. This further confirmation of the original evaluation did not appear to require a repetition of the staff's original arguments, even though they might be amplified somewhat at the present time.

Some examples of confirmatory information that has been developed recently are the following:

- The report "Assessment of Maintainability of LMFBR Designs", by K. P. Johnson, et al. (NP-17414, February 1981) has confirmed in some detail the equivalent level of maintainability problems in either loop or pool reactors.
- The successful startup initial testing (including natural circulation tests) and operation of FFTF has added to the experience with loop-type systems.
- The initial steam generator problems with Phenix appear to have been reduced to the point where designers believe that the basic problems in this equipment are understood and can be corrected.

- The "LMFBR Conceptual Design Study" (CDS-400-2, Department of Energy, 1981) has confirmed the present-day applicability of the general concept and most of the detailed design features of the CRBR. This study represents the efforts of a large group of experienced engineers and designers.

On the other hand, neither CEC nor any other source of information available to the staff has revealed any part of the LMFBR experience of the last 5 years that is not supportive to the conclusions drawn in the original FES. Consequently the staff still believes that no revisions to the sections on alternatives (Section 8.4.1 to 8.4.6) are necessary.

MIL-2--Plant Objectives vs. Alternatives: Alternatives to the proposed CRBR design are covered in the FES and FES Supplement Chapters 8 and 9. Alternatives that do not meet the objectives adopted for the program are not discussed. Some of the objectives listed in Section 8.3 are "to demonstrate the technical performance, reliability, maintainability, safety, environmental acceptability, and economic feasibility of an LMFBR central station electric power plant in a utility environment."

The suggestion that an alternative that needs to be considered is "doing without the CRBR technology and substituting conservation and alternative renewable sources" has been rejected, because the plant objectives would not be accomplished in this way.

The objectives of the plant do not require the production of a specific amount of electricity.

MS-1--CRBR Hazards: The staff assumes that Mrs. Sinclair's phrase "inherently dangerous" refers to those hazards that would exist in a bare plant in the absence of all added safety features. In view of the low pressure and large subcooling in LMFBRs, it is difficult for the staff to conclude on balance that the LMFBRs represent a higher inherent level of hazard than do the light-water-cooled reactors. But perhaps more to the point is the fact that, in both cases, designers have been able to provide features to prevent, mitigate, or contain such hazards to the extent that a satisfactorily high degree of safety appears to be feasible for either type.

In a developing technology such as the LMFBR, it is inevitable that new and possibly improved concepts will be suggested and even developed during the interval between conception and implementation of any long-lead project. The Clinch River design, however, has not been shown to be seriously outmoded in any way, and interim periods allowed by the delays in its history have been used to incorporate features that are more advanced than those of the existing LMFBRs, such as the heterogeneous core arrangement.

Information obtained by the staff indicates that the Phenix reactor is operational history has been eminently successful after an initial intermediate heat exchanger problem, and that cutbacks in projections for French nuclear power reflect, as they do in this country, a revised estimate of future electrical demand rather than an overall revision of safety concerns.

SA-3--Pool-Type Reactor Experience: The staff does not concur in the view that the French experience with pool-type reactors renders the loop-type reactors obsolete before being built. The discussion of pool and loop type reactors in

Section 8.4.1 of NUREG-0139 remains valid today. The claims of obsolescence of loop-type reactors have not been supported by specific showings of lack of efficiency, technical performance, safety, maintainability, breeding ratio, or any other characteristic. The staff finds today, as it did in 1977, no compelling preference for either type, and the staff still believes that the loop choice for CRBR satisfies its goals and allows sufficient flexibility to proceed with either type in the future.

12.8.4.4 FFTF Role Expanded

SA-4--Use of the FFTF: Expanding the role of FFTF to include a demonstration of LMFBF electric generating technology was considered in the 1977 FES (Section 8.4.4). The reasons for rejecting this option as expressed there are still valid today: the demonstration is too small and conflicts with the FFTF role as a fuel test facility.

12.8.4.7 Nonproliferation Alternatives

CEC-2--Proliferation Risk: The CEC contends that the LMFBF fuel cycle represents a greater proliferation risk than some other fuel cycles, quoting the 1977 Office of Technology Assessment report "Nuclear Proliferation and Safeguards" as evidence. The comment also implies that construction of the CRBRP will lead, presumably indirectly and over a long time, to the acquisition by other nations of LMFBF fuel cycle technologies.

The staff has not evaluated the relative proliferation resistance of the various fuel cycles or the likelihood that development of the CRBRP will lead eventually to the further proliferation of nuclear weapons. Such issues were beyond the scope of the staff's assessments. However, they were evaluated in the International Nuclear Fuel Cycle Evaluation effort. For an assessment of the relative proliferation resistance of fuel cycles, the results of INFCE should be consulted. In addition several foreign nations have independent LMFBF programs, and the Carter Administration policy of curtailing the U.S. LMFBF program in hopes of influencing foreign activities does not appear to have worked. The purpose of the staff's review was not to evaluate U.S. nonproliferation policy, but to determine if DOE's proposals for safeguarding the CRBRP fuel cycle are adequate. Because the CRBRP and all of its supporting facilities would be located in the U.S., the review was limited to consideration of subnational theft, diversion, and sabotage.

The staff recognizes and shares the concerns that have developed since 1977 in regard to potential diversion and required safeguards that would accompany any widespread industrial extension of the breeder concept. The staff is also aware of the Office of Technology Assessment (OTA) evaluation, which placed maximum favorable weighting on the inherent materials involved and their separability, and minimum weighting on external physical security measures that could be provided. Although such a study is useful in developing conceptual points of view, it does not fully evaluate the total safeguard picture. Certainly any individual facility can be adequately safeguarded by conventional procedures. Therefore, CRBR itself can be adequately safeguarded.

The Molten Salt Breeder Reactor was omitted from consideration in the alternatives covered in the original FES because of the immature state of its development. It was not regarded as an alternative that could fulfill the objectives

of licensing and timing at this stage of its development. No further developments have occurred since 1977 to add to this perception. The OTA rating is valuable only in a conceptual sense and does not reflect the limited technological development of the concept. If the Molten Salt concept is ultimately adopted for exploitation in the power industry, the value of LMFBR technology as a precursor demonstration will be indirect at best, but this is not expected within a generation of completion of the CRBR.

An additional aspect of the proliferation problem is associated with the extent to which other nations follow the U.S. example in nuclear matters. It has been suggested that the implementation of the CRBR at this time would provide an example that would only encourage less responsible foreign nations to enter into breeder reactor programs for weapons purposes (Wall Street Journal, September 27, 1982). It is not clear, however, that other nations are strongly influenced by the example of the U.S. in determining the type of program they enter. In the optimism of 1977 it was suggested that if the U.S. discontinued its breeder program in the interests of nonproliferation, other nations would be encouraged to follow the same course. As it turned out, other nations took a serious look at alternatives, and were willing to consider variations more suitable for control of proliferation; however, they were unwilling to cancel any of their basic plans for reactors or fuel reprocessing. Apparently the role of the U.S. as an exemplar had been overstated, because other nations obviously base their programs to supplement their energy resources on their own perceived needs.

The staff therefore concludes (1) that safeguards problems for an individual facility like CRBR are manageable, and (2) that the impact of CRBR as an example leading to foreign weapons proliferation would be minimal.

12.9 Alternatives

12.9.1 Energy Sources

MIL-2a--Purpose of the CRBR: The comments appear to ignore the purpose of the CRBRP, which is to demonstrate the ability of an LMFBR power plant to meet certain objectives specified under DOE's LMFBR Program (see Chapters 1 and 8 of this supplement). Obviously, no alternative such as coal or solar energy or conservation can demonstrate the operation of an LMFBR power plant.

12.9.2 Sites

DOE-P through V--Site Selection: The staff concurs with and has made most of the changes in text suggested by those comments.

UCS-5--Accident Consequences at Alternatives Sites: Analyses of postulated plant accident consequences for each proposed alternate site are not called for by the Commission's Regulatory Guide 4.7 or its Environmental Standard Review Plan (NUREG-0555). The staff does not believe such analyses are necessary in view of its assessment that accident risks at the CRBRP can be made acceptably low (see Section 7.1 and Appendix J).

Selection of the "best available site" is not required by NEPA or the NRC. CEQ regulations (40 CFR 1502.14) state that agencies shall "rigorously explore and objectively evaluate all reasonable alternatives," and NRC's proposed rule on

alternate sites (see Appendix K) calls for selection of the proposed site from among the best that could reasonably be found.

Although the most remote site may imply the "best" protection of the public, protective features included in the plant design make the selection of a remote site unnecessary.

12.9.2.4 Alternative New Sites in the TVA Service Area

DOE-R--Table A9.1: Table A9.1 has been changed to include Elk River.

NRDC-47-- Meeting the Timing Objective: The staff's position is that it is relative whether an alternative would permit the project to meet its objectives. Therefore, the staff believes that the ability of the project to meet the timing objective at an alternative site is a logical consideration.

NRDC-48--Choice of Review Option: Under the proposed rule for review of alternative sites (see Appendix K), an applicant may choose either of two site selection methods identified in Section VI. "The general rationale for the product-oriented approach," as stated in D.4 on page K-5, "is that candidate sites that pass all of the proposed threshold standards would be unlikely to have substantial, unidentified, adverse environmental impacts." On that basis, and considering that TVA screened more than 100 potential sites in determining its slate of candidate sites, the staff believes it is highly unlikely that any substantially better sites were overlooked.

NRDC-49--Further Endangerment to Threatened or Endangered Species: The applicants have concluded that there would be no further endangering of Federally listed threatened or endangered plant or animal species. The staff has reviewed the applicants' data and performed a biological assessment that concurred with this conclusion. The Fish and Wildlife Service reviewed that staff's assessment and determined that construction and operation at the CRBR site would not affect any listed species (Appendix B).

The staff has concluded that the CRBR project would not affect the four state-listed endangered or threatened bird species (Section 2.7.1.2.2).

NRDC-50--Threshold Criteria: The staff has indicated in Section 9.2.4.1 the sources of its data for the alternative site analyses, including NRC environmental statements. The staff believes that the reconnaissance-level data provided by the applicants was sufficient to support the applicants' analyses necessary to reach reasoned conclusions pertaining to the selection of the applicants' candidate sites. In addition, the staff's own review of the candidate sites and threshold criteria concurred with the applicants' selection of the candidate sites.

Based on reconnaissance-level information for the candidate sites and the staff's own biological assessment for the CRBR site, the staff concludes that the issue of reexamination of criterion (2) (Endangered Species) for candidate sites is not needed.

NRDC-51--Why Only Four Sites: The applicants' ER Section 9.2 and Appendix A provided considerable information about 11 new and two hook-on sites in the TVA service area; this information was used by the staff in preparing the 1977 FES.

Recently, the applicants have reexamined the 11 new sites plus the Yellow Creek Nuclear Plant site using the approach set forth in NRC's proposed rule on alternative sites (see Appendix K). The results of that effort are documented in ER Appendix G.

While more than four of the above sites could have been included in the final slate of candidate sites, NRC's proposed rule does not require that more than four be considered if they are reasonably representative of the diversity of land and water resources within the region of interest. The staff believes that this is true of the five TVA candidate sites (including the proposed Clinch River site) that were compared in Appendix L of the Draft Supplement.

Section VI.2.a of the proposed rule does state: "one alternative site must have the same water source as the proposed site." However, this is not a mandatory requirement for this review because the rule has not been adopted yet by the Commission. Furthermore, considering another site on the Clinch River would probably not be productive inasmuch as none of the potential sites on the Clinch River, except the proposed site, emerged as a candidate from TVA's screening analysis (see ER page G-12).

12.9.2.5 Selected Alternative Sites in the TVA Service Area

NRDC-52--Protection of Striped Bass: Before operation of CRBR begins and after the completion of studies on striped bass, as specified in the NPDES permit, a determination will be made as to the necessity to limit the thermal discharge of CRBR for the protection of striped bass during high ambient river temperature and extended no-flow conditions. At that time, procedures to alleviate any possible thermal losses as a result of CRBR operation will be established.

The staff has examined the limitations and requirements imposed by the NPDES permit and concurs with EPA that they are adequate. The NPDES permit does not address the protection of endangered freshwater mussels because the staff and the FWS have concluded that the potential for a significant impact to this group of organisms is inconsequential.

NRDC-53--Cleared TVA Sites: In the Draft Supplement, the staff has considered the environmental advantages of siting the CRBR plant on an already cleared site (Appendix L, Section 1, TVA Sites). In addition the staff in Section 9.2.5 of Draft Supplement wished to merely point out that because this proposed CRBRP site is zoned for industrial use, any future development of this site would most likely cause some of the same construction impacts that would be attributable to the CRBRP. For a discussion of thermal and radiological impacts, see Sections 5.3.2 and 5.7.

NRDC-54--Cost Estimates: The applicants contend that construction in place at Hartsville, Phipps Bend, and Yellow Creek is not applicable to the breeder design and consequently the recent availability of these sites does not positively affect their cost comparison with the Clinch River site. Further, the staff notes that the preponderance of the incremental cost, as indicated in Table A9.3, is attributable to delay, which should result regardless of the status of these sites.

Table 9.4 in the February 1977 FES detailed cost differences between Clinch River and alternative plant designs (hook-on plants). All TVA alternatives

being considered in Table A9.3 represent a common design and, with the possible exception of site preparation, no cost differences exist with respect to the types of costs delineated in Table A9.4. The cost elements in Table A9.3 represent incremental costs attributable to delay and the need to re-do work that has already been done at the Clinch River site. These costs are principally time dependent and are largely invariable with respect to the alternative sites under review. Consequently, the staff does not believe that site-specific cost estimates would contribute significantly to the conclusions to be drawn from the cost data.

NRDC-56--Sites Reserved for Commercial Plants: The staff's understanding is that TVA offered the proposed Clinch River site during the 1972-74 time period because the site was considered satisfactory for the LMFBR demonstration plant and because it met the TVA new-site criteria. The criteria are identified on page 9-2 of the FES as follows: "The site should be available immediately; and the site should be one which is not expected to be used for a commercial generating plant in the near future."

There has been no indication from the applicants that TVA intends to modify the above criteria; however, the applicants have gone beyond those criteria (ER Appendix G) in considering alternative sites in accordance with the NRC's proposed alternative sites rule.

NRDC-82--Research Costs: The second sentence on page 9-10 of the supplement (Section 9.2.5) has been revised to read: "The staff does not feel it can derive a meaningful independent estimate in this instance because of a number of differences between the breeder reactor and the light water reactor technologies for which the CONCEPT code is applicable." The estimate of research and development costs reported in Section 10.4.1.3 and Table A10.3 was provided by the applicant and has a high level of certainty because the bulk of these costs have already been spent.

12.9.2.6 Alternative TVA Sites Outside Its Service Area and Alternative DOE Sites

DOE-W--Plant Revenues: The staff's estimate for plant revenues of \$350 million (year of expenditure dollars) is based on the 1981 average cost of coal in the East South Central region ($170.4¢/10^6$ Btu) escalated at 8% per year, assuming an average plant heat rate of 11,000 Btu/kWh. Given TVA's projected reserve margins, the high proportion of its capacity dependent on coal, and the fact that the CRBR is projected to perform in a base load mode, the staff contends that it is reasonable and conservative to assume that substitution would be primarily from TVA's average-cost coal units rather than from its more costly marginal units.

The staff's estimate of revenues at the Hanford site (\$1097 million) assumes the breeder reactor would displace equal portions of coal- and oil-fired energy. 1981 average costs for coal and oil in the Pacific region were $121.0¢/10^6$ Btu and $662.6¢/10^6$ Btu, respectively. These costs were adjusted based on an 11,000 Btu/kWh plant heat rate and 8% per year escalation in fuel prices. The displacement of oil is predicated on low hydro energy in the region. The staff acknowledges that if hydro conditions are better, the likelihood of such a heavy reliance on oil is reduced and revenues would be lower. The staff, however, believes that its assumptions are reasonable and that they

can be viewed as conservative in the comparison of costs at the Hanford and Clinch River sites (Table A9.4).

DOE-X--Water Supply Costs: The staff has revised Table A9.4 to include the incremental costs for the water supply line at the Hanford and Idaho sites. Technically, this adjustment also impacts the calculations in Table A9.5 for both these sites. However, its effect on these values is inconsequential and thus no changes have been made.

NRDC-57--Site Isolation Factors: For the readers' convenience, Table 9.5 of the FES was retained, and it has been further updated by notations in Section 9.2.6 of this supplement. However, the staff's current assessment of the three DOE candidate alternative sites in comparison with the proposed Clinch River site is in Section 2 of Appendix L in this supplement.

Contrary to the NRDC comment that the staff's characterization of atmospheric dispersion and site isolation factors constitutes a misapplication of the proposed alternative sites rule, the rule does not require that either factor be considered, except that each candidate site used in the subsequent comparison of alternatives under the method specified in VI.1.b must meet threshold criteria VI.2.b(7) and (8). For additional discussion of these factors, see the staff's responses to the NRDC comments on Appendix L, specifically NRDC-147 concerning meteorology and NRDC-150 concerning population density at Hanford versus Clinch River.

NRDC-58--Utilities Participation: The term "participate extensively" means to take a major role in the engineering, construction, and operation of the LMFBR demonstration plant. To provide the utility environment in which this plant is to achieve its objectives, some utility or group of utilities must allow the plant to be interconnected with their power system. The applicants have recently reaffirmed that the utility groups that could provide for such operation at the Hanford, Idaho, or Savannah River alternative sites are not in a position to do so (see ER Appendix F, Sections 2.1.1.13, 2.1.2.13 and 2.1.3.13; letters from the utility groups to that effect are included among the exhibits for Appendix F).

NRDC-59--Schedule Impacts: The phrase "today's regulatory climate" should have read "today's political climate." The comment is certainly correct in noting that efforts have been made to accelerate the CRBR licensing process. However, the staff's previous estimate of a 27-month delay for moving to an alternative site was optimistically based on the assumption that the utility entities in the vicinity of the new site and the Congress would give priority to implementing the necessary arrangements and legislation (FES page 9-15, third paragraph). Today, the staff believes that assumption is less certain in view of the many demands upon the Congress to deal with current economic and international problems.

NRDC-60--Hanford Revenues: The staff believes the use of conservative assumptions in estimating revenues at the Hanford site is consistent with recent deferrals at WPPSS (see DOE-W above also).

NRDC-62--Radiological Risks: Changes in CRBRP design since 1977 have primarily served to reduce the risks from CRBRP, and the continuing research on and development of LMFBRs in the interim have served to reduce the uncertainties in CRBRP accident risks; neither calls for changes in Section 9.2.6.4.

As reported in NUREG-0786, the staff has determined that the Clinch River site is suitable for a reactor like the CRBRP. Although the DOE (previously ERDA) sites provide noticeably more remote locations, because the objective of the CRBRP is to demonstrate the operation of an LMFBF central station electric power plant in a utility environment, a site such as the Clinch River site is more suitable for meeting the objective.

12.9.2.7 Conclusion

NRDC-61--Benefits of LMFBF Program: The staff's conclusion in the FES supplement that any delay would result in reduced benefits of the LMFBF program is based on present-worth considerations. The benefits, which are principally of an informational and research and development nature, will be reduced because they are subject to a real discount rate.

As a part of the Clinch River exemption request, the applicant has addressed the issues of improvements in design that could accompany such a delay. The applicant argued that the design has already been fine tuned and that further effort in these areas would be essentially wasteful and nonproductive.

The basis for the staff's conclusion that the Hanford, INEL, and Savannah River sites are not substantially better than Clinch River is provided in Appendix L.

12.9.4 Benefit-Cost Comparison

NRDC-63--Improved Alternative Designs: Since 1977 approximately \$1 billion (in year of expenditure dollars) has been spent on design, testing, and procurement for the Clinch River plant; little or no funds or effort has been expended on the alternative designs. Consequently, from today's perspective, the real economic cost (to-go cost) of Clinch River has decreased relative to the alternatives. It is for this reason that the FES supplement concluded that there has been "...no improvement in the ranking of these alternatives."

12.10 Evaluation of the Proposed Action

12.10.1 Unavoidable Adverse Environmental Impacts

12.10.1.1 Abiotic Effects

NRDC-64--Land Use: The staff believes the proper assessment has been made in this section. For further staff response to this issue, the response to NRDC-26.

NRDC-65--Water: The staff found no unavoidable adverse impact associated with blowdown or thermal plume.

NRDC-66--Compensation for Local Communities: The staff did not consider the effects of PL 81-874 in order to make the analysis of local revenues conservative. PL 81-874 is being considered for modification by the Congress; the staff has no insight into the future of the program. The words "additional compensation" are meant to imply a range of benefits not necessarily limited to additional revenues.

12.10.1.2 Biotic Effects

NRDC-67--Terrestrial Effects: The staff's assessment included the determination that no rare, unique, or endangered or threatened biota would be affected by construction or operational activities at the CRBR site, including the additional land requirements outlined in Section 4.2.1. In addition, the staff compared onsite terrestrial resources with those near the site and concluded that they were comparable. Thus, the staff determined that the loss of terrestrial habitat on site (Section 4.4) was not environmentally significant in terms of terrestrial resources.

The value of 1% (Section 10.1.2.1) refers to the total affected wildlife.

NRDC-68--Aquatic: An area measurement rather than a volume measurement to describe inriver construction-related impacts was used because the former is a more meaningful description of the extent of impact. The disturbance of a large area of river bottom by the removal of a given amount of material would have a greater impact than the removal of the same amount of material from a much smaller area of bottom.

Dredging and filling will be temporary activities. Studies by Cairnes et al. (1971) have documented the potential of temporarily disturbed substrates to be rapidly recolonized.

12.10.1.3 Radiological Effects

NRDC-71--Other Effects: See responses to NRDC comments in Sections 12.5.7, 12.7, 12.12.D, and 12.12.J.

12.10.2 Short-Term Use and Long-Term Productivity

12.10.2.4 Decommissioning

CEC-6--Decommissioning Plan: As stated in Section 10.2.4.1 of the Draft Supplement to the FES, NRC regulations and guidance on decommissioning are being revised. The revised regulations may include requirements for preliminary decommissioning plans. The NRC has not, however, finalized its position on the scope of such preliminary decommissioning plans or whether preliminary decommissioning plans will be required. A proposed revision to regulations on decommissioning is scheduled to be published in February 1983. All applicants, including the CRBRP applicants, will be required to comply with any regulatory changes that require preliminary decommissioning plans. Based on previous decommissioning experience and studies, however, the staff does not see any feature of the CRBRP that would prevent decommissioning of the facility in an environmentally acceptable manner.

The NRC staff feels that it would not be prudent to establish special requirements for a preliminary decommissioning plan submittal for the CRBR alone, prior to developing guidance on the content of such plans. As indicated in the quoted GAO recommendations, early determination of the method to be used for decommissioning may reduce cleanup costs, avoid delays in decommissioning, and enable Federal agencies to better estimate waste disposal requirements. These benefits may occur with the development of preliminary decommissioning plans, but a negative impact on the safety of a plant may also occur if the NRC precipitously imposes design changes to facilitate decommissioning.

The referenced GAO comments suggest selecting a plan now so that funding for decommissioning a reactor can be accumulated during the reactor's useful life. Establishing a funding process is probably not applicable for the Federally owned CRBR, which will likely involve appropriation of funds by Congress when they are needed for decommissioning.

EPA-16--Deep Geologic Disposal: The staff agrees with EPA that possible deep geologic disposal of some components is a secondary impact. Data on the cost, availability, feasibility, and environmental impact of such a facility are not available because no deep geologic disposal facility has been selected. The NRC is revising regulatory requirements for land disposal of radioactive wastes (10 CFR 61) to allow the disposal of material containing small quantities of long-lived radionuclides such as niobium-94 and nickel-59 in licensed low-level waste burial facilities. Therefore, a deep geologic disposal facility may not be needed for any reactor decommissioning wastes or may be needed for a smaller quantity of waste than that indicated in the Draft Supplement to the FES.

GF-1--Decommissioning Costs: Mr. Flack discusses a Bechtel report on decommissioning costs that was submitted to the Public Service Commission of Georgia. Mr. Flack graciously provided a copy of a Bechtel Report* to the NRC by a letter dated September 20, 1982 (G. Flack to P. Erickson). Mr. Flack stated that the Bechtel report indicated higher decommissioning costs than did the Draft Supplement. The following is a comparison of the costs given in the Draft Supplement and those in the Bechtel report:

Estimated Decommissioning Costs (1978 dollars)

	Draft Supplement to FES for CRBR: PWR, 3500 Mwt	Bechtel Report, Hatch 1 and 2: BWR, 2436 Mwt (single-unit cost)
SAFSTOR (100 yr)	\$41.8 million	\$29.8 million
DECON/Dismantlement	\$33.3 million	\$49.9 million

There are some differences in the bases for the above cost estimates. The FES draft supplement references a PWR and the Bechtel report a BWR. The draft supplement does not include the cost of removal of nonradioactive structures as their removal is not an NRC requirement. The Bechtel report includes the cost of removal of the nonradioactive structures. There may also be other differences in the bases for these two reports that would account for the cost differences. The net result of this preliminary comparison of the two reports, however, does not indicate a need to increase the staff estimate of the cost of decommissioning the CRBR.

Mr. Flack mentions Bechtel estimates of \$59.3 million for decommissioning by safe storage with deferred removal and \$99.8 million for decommissioning by prompt removal (1978 dollars) in his September 20, 1982 letter. These cost figures are the totals for two units (Hatch 1 and 2). Mr. Flack also, mentions

*"Decommissioning Study for the Edwin I. Hatch Nuclear Power Station," January 1979.

escalated cost estimates of \$110 billion and \$817 million in the Bechtel report. These escalation values simply reflect an estimated loss in the value of dollars based on Bechtel's projected inflation rate of 6% per year compounded annually for 140 years for the safe storage alternative and 40 years for the prompt removal alternative.

LRC-1, -2 and -3--Health Effects: Radiation protection is concerned with the protection of individuals, their offspring, and mankind as a whole, while still allowing the beneficial utilization of radioactive materials. 10 CFR 20, which sets conditions and limitations of radioactive materials, also embodies the ALARA concept (10 CFR 20.1), which states that licensees, in addition to complying with the radiation exposure limits set forth in 10 CFR 20.1, should make every reasonable effort to maintain radiation exposures to workers and the public as far below the limits reasonably achievable (ALARA). This is because it is assumed, conservatively, that any dose of radiation may be harmful. (See also the response to SS-3 in Section 12.5.7 and Section 5.7.2.5 of the supplement for further information on the risks from exposure to radiation.)

LRC-4--Cleanup Costs: The environmental impacts of postulated accidents are discussed in Section 7 of the 1977 FES and Section 7 and Appendix J of the Draft Supplement to the FES. Cleanup of contamination produced by a major accident would be considered part of accident recovery costs. After such cleanup, the reactor may be reconditioned for operation or it may be decommissioned.

MS-4--Primary Sodium Activity at Fermi 1: The Fermi 1 primary sodium activity has been analyzed and the results reported in a letter from E. L. Alexanderson, PRDC, to A. Giambusso, NRC, dated May 30, 1975. The following is a summary of the estimated activity in microcuries per cubic centimeter for each radionuclide as of that date:

- | | |
|--------------------|---------------------------------------|
| • sodium-22 | |
| 2.6-year half life | $6.82 \times 10^{-3} \mu\text{Ci/cc}$ |
| • cesium-137 | |
| 30-year half life | $6.82 \times 10^{-4} \mu\text{Ci/cc}$ |
| • strontium-90 | |
| 29-year half life | $3.41 \times 10^{-4} \mu\text{Ci/cc}$ |
| • plutonium | no detectable plutonium |

The total amount of residual primary sodium in systems at Fermi 1 was estimated by the licensee to be 345 gallons, or about 2760 pounds (Fermi 1 First Quarter Report, 1974). As of May 30, 1975, the total quantity of radioactivity in the residual sodium was, therefore, 1.02×10^{-2} curies, based on the above radionuclide concentrations. Because two half-life periods have occurred since May 1975 for sodium-22, its concentration would be reduced by a factor of 4. The resultant quantity of radionuclides in the Fermi 1 primary system residual sodium would be 3.57×10^{-3} curies total as of October 1982. The 3.6 millicuries of activity in the residual primary sodium at Fermi 1 does not represent a serious disposal problem because the potential radiation exposure to workers from the sodium would be a few millirems per hour. The primary system at Fermi 1 is maintained under slight pressure with carbon dioxide. The carbon dioxide slowly passivates the residual sodium by converting it to sodium carbonate.

NRDC-72--"Unacceptable" Impacts: The term "unacceptable" is used in the following sentence: "On the basis of environmental reports and assessments of decommissioning actions accomplished to date no unacceptable impacts have resulted from decommissioning." In this section, this sentence means that, to date, licensee decommissioning plans and environmental reports either have been accepted as proposed or accepted after modification to meet NRC requirements. One requirement imposed by the staff on several licensees is the criterion for releases to unrestricted access, as discussed in Section 10.2.4.2 of the Draft Supplement to the FES.

NRDC-73:--Decommissioning Alternatives: If a licensee chooses safe storage as part of the decommissioning plan, the staff requires the licensee to submit detailed Technical Specifications and safety analyses to ensure that adequate provisions have been made for access control to radioactive areas, radiation monitoring, environmental monitoring, maintenance of the facility, control of residual radioactivity, and reporting to the NRC. In addition, the NRC conducts periodic inspections at the facility. The removal of fuel assemblies is considered part of reactor operations, not decommissioning.

NRDC-74--Exposure Model: The exposure model is utilized as follows: If the maximum exposure level permitted is 5 $\mu\text{R/hr}$ and it is assumed that an individual stays in that exact spot for 2000 hours each year, the total exposure the individual would receive is $2000 \times 5 \times 10^{-6} \text{ R/yr} = 1 \times 10^{-2} \text{ R/yr} = 10 \text{ mR/yr}$. The figure of 2000 hours is a reasonable estimate of the amount of time a worker would spend on the job in 1 year, assuming a 40-hour week and 50 working weeks a year. The 10 mR/hr exposure assumed is conservative because it is unlikely that an individual in any work environment would spend all his working hours in any one spot in a facility for an entire year. The likelihood of an individual's remaining in one spot year after year to accumulate additional exposure at the maximum rate is even more remote. In addition to the 5 $\mu\text{R/hr}$ limit for gamma radiation, licensees have been required to comply with the surface contamination limits of Regulatory Guide 1.86. The number of individuals potentially exposed to the residual radiation from a decommissioned reactor facility is very small because the residual activity would largely be confined to the reactor containment building and adjacent buildings. The activation products, following dismantling for instance, would primarily be confined to the remaining reactor shield structure after removal of the reactor vessel and shielding material.

In response to questions on long-lived radionuclides, the applicants have estimated the maximum exposure rates from niobium-94 and nickel-59 to be 2.2 rems/hr and 9 mrems/hr respectively (see Supplemental Responses to the 18th Set of Interrogatories, August 6, 1982). These values NUREG/CR-0130. It may be possible to measure the amount of each of these radionuclides at the end of a long-term safe-storage period if the gamma emissions from cobalt-60 are sufficiently reduced. The gamma exposure from cobalt-60 in the reactor vessel immediately after reactor shutdown is more than 10,000 times higher than the exposure from the above long-lived isotopes. This prevents any measurement of the quantities of these isotopes at that time. The amount of long-lived isotopes would be reevaluated at the end of the safe-storage period on the basis of direct radiation measurements, radiochemical analysis, or recalculation based on actual total integrated neutron flux in the reactor vessel.

NRDC-75--Entombment Periods: The Hallam, Bonus, and Piqua reactors were entombed with entombment design-life periods of 100 to 140 years. Therefore, a 100- to 150-year entombment period is not unreasonable. Fuel assemblies would be removed from the reactor core at the end of a reactor's operational life as part of operations, not decommissioning. Because of the residual radioactivity at the site, access control would be required but "safeguarding," which relates to preventing the theft of fuel, would not be a requirement after that fuel is removed from the site.

The staff agrees that no "deep geologic disposal facility" currently exists (see also the response to EPA-16 above).

NRDC-76--Security Costs: The cost estimates given in Section 10.2.4.5 were obtained from NUREG/CR-0130 and NUREG-0586. These costs include the cost of waste burial fees that, in turn, include the costs of continued security at low-level waste burial sites. These costs are described in more detail in NUREG/CR-0130.

There is no specific level of exposure designated as as low as is reasonably achievable (ALARA). The staff will review the procedures, equipment, and techniques proposed by a licensee in the decommissioning plan. The staff will then concur in the plan or require alternative methods to ensure that exposures are maintained ALARA. Improvements in technology, remote handling, and instrumentation may change what the staff today considers ALARA.

NRDC-77--Fermi 1 Shutdown: Fermi 1 was not shut down as a result of reactor failure. The reactor was repaired, the primary system decontaminated, and the reactor returned to full-power operation (200 MWt) after the October 5, 1966 fuel-melting incident. For additional information on the Fermi 1 accident, see the response to SC-7 below. The total occupational exposure received during Fermi 1 decommissioning operations was 25.9 person-rems.

NRDC-78--Fermi 1 Primary Sodium: Discussions with Fermi 1 personnel indicate that Detroit Edison (the Fermi 1 licensee) will begin shipping primary sodium to the DOE Oak Ridge site within one year for use in the CRBR program.

NRDC-79--Cost Bounds: At this stage of the licensing process, the staff considers it necessary only to bound the costs of decommissioning, not to determine the least costly option. The staff finds that the costs presented by the applicants adequately bound the cost of decommissioning the CRBR.

SC-1--Increased Costs of Decommissioning: The NRC regulations due to be published in proposed form in February 1983 will be based on the same NUREG reports that have been used as a basis for Section 10.2.4 of the Draft Supplement to the FES. The criteria for release of facilities to unrestricted access, to be published in the forthcoming regulations, are not expected to change significantly from those stated in Section 10.4. One could speculate that more strict regulations in the future will increase costs, but, one could also speculate that improvements in technology will decrease decommissioning costs. The cost estimate in the 1977 CRBRP FES of \$70 million (1977 dollars) for complete site restoration is actually higher than the estimates given for any alternative in the Draft Supplement.

SC-2--Decommissioning Radiation Surveillance: The staff agrees that a range of distance from zero to 200 cm from a surface is not a major factor for gamma radiation exposure from a large, uniformly radiating, plane surface. In the case of the nonuniform source or a point source, the potential occupancy time for an individual in the radiation field of this source would be less than the occupancy time in an area of a large uniform-plane source. Because the maximum radiation level permitted is 5 $\mu\text{R/hr}$ in either case, the staff concludes that the potential total exposure to an individual would be less with a nonuniform or point source. Contribution of dose to the skin from the beta emissions of cobalt-60 would not be significant compared to the whole body dose from gamma emissions. In addition, Regulatory Guide 1.86 specifies limits for fixed or loose surface contamination that would require decontamination or removal of structures or equipment contaminated with cobalt-60 above those limits.

SC-3--End-of-Life Source Term: Licensees will be required to recalculate the source term at the end of the life of the plant, as part of their decommissioning plan. Licensees will be required to demonstrate that the alternative they select is environmentally acceptable. An alternative that requires maintenance and surveillance for 250 to 500 years would probably not be accepted by the NRC.

SC-5--Disposal of Radioactive Sodium Primary Coolant: The Fermi 1 primary sodium was analyzed on May 28, 1975 by the Fermi licensee. The following is a summary of the primary sodium activity in microcuries per cubic centimeter for each radioisotope as of May 28, 1975:

- sodium-22
2.6-year half life $6.82 \times 10^{-3} \mu\text{C/cc}$
- cesium-137
30-year half life $6.82 \times 10^{-4} \mu\text{C/cc}$
- strontium-90
29-year half life $3.41 \times 10^{-4} \mu\text{C/cc}$

In PSAR Amendment 68, the applicants have committed to develop a method for disposal of radioactive sodium by the time the operating license stage is reached. The estimate of \$1.25 million (in 1978 dollars) for sodium disposal was based on actual experience at Fermi 1 for disposal of primary sodium. The cost estimate for "handling" the sodium includes the cost of removal from the reactor, transferring sodium to shipping containers, and shipping it to another user.

SC-6--Secondary Sodium: The secondary sodium is maintained at a higher pressure than the primary system. The higher secondary pressure plus the low level of long-lived radionuclides in the primary system are likely to keep the secondary system free of radioactivity. In addition, there are (1) a system for monitoring the secondary sodium for radioactivity and (2) a cold trap system for removing radioactivity from the secondary system.

SC-7--Accident Recovery: The accident at Fermi 1 was not the cause of its decommissioning. The accident, which involved the melting of two fuel assemblies, occurred on October 5, 1966. Damaged fuel was replaced, some modifications to the facility made, the primary sodium decontaminated, and the reactor returned to operation. The reactor resumed low-power operation on July 18,

1970 and returned to full-power operation, 200 Mwt, on October 16, 1970. Fermi 1 was shut down on December 1, 1971 and subsequently decommissioned because of a lack of funding for its continued operation.

Accident recovery is not considered to be part of the cost of decommissioning. Reactor accidents are covered in Section 7 of the FES and in Appendix J of the Draft Supplement.

12.10.3 Irreversible and Irretrievable Commitments of Resources

NRDC-80--Fuel Recycle Philosophy: Examples of possible fuel consumption under different recycle plans are given in Section 10.3.4.2 of the Draft Supplement. These examples characterize the uncertainties in the fuel recycle philosophy.

The staff is not aware of any calculations of breeding ratio of the heterogeneous core that differ substantially from those of the applicant.

12.10.4 Benefit-Cost

12.10.4.1 Benefits

NRDC-83--Economic Effects of Deferral or Termination: Although it is possible that the employment and payroll benefits from CRBR might be reduced as a result of termination or deferral, this possibility is beyond the staff's mandate, which is to evaluate the construction and operation of the CRBR.

NRDC-81--Summary Table: Based on the past performance of LWRs, the staff views the applicants estimate of an average annual capacity factor of 60% as reasonable, albeit at the high end of what is typically achievable. No sensitivity analysis was performed on this variable because the energy to be produced by the CRBR is viewed as a minor secondary benefit and, consequently, even significant fluctuations in the capacity factor would have little effect on the overall benefits attributable to the LMFBR program.

OCRE-6--Effects on Local Communities: Increased taxes and employment resulting from the construction and operation of CRBRP are not included in the staff's cost-benefit consideration. Rather, these effects are included solely for disclosure purposes.

WE-9 through 13--Cost-Benefit of CRBRP: The principal benefits of the CRBR project would result from obtaining research and development knowledge and from gaining experience and testing the LMFBR concept in a commercial environment. The energy to be generated by the CRBR has consistently been identified by the applicants and the NRC as a minor secondary benefit of the proposed action. Thus, the commentor's attempts to contrast the benefit of electrical generation from CRBR with CRBR's total cost in order to reach a conclusion regarding the merits of the project is ill conceived.

Further, TVA has committed to purchase CRBR's output during the demonstration period at a price equivalent to the cost of energy that would otherwise have supplied TVA's marginal energy requirements. Under this formula, TVA rate-payers will pay no additional cost for this energy and will have the benefit of 350 MWe of additional capacity, with corresponding favorable reliability implications. The CRBR energy will be consumed by TVA customers regardless of

the absolute need for the unit on the TVA system. The level of demand during the demonstration period will only affect the marginal energy source to be displaced.

At the end of the demonstration period, TVA commitment to CRBR ceases and the utility will have the option of purchasing the plant. There is simply no reason to expect--nor is it logical to expect--that the sale price will capture the full undepreciated total cost of all research and development, construction, and operating costs (during demonstration), plus inflation to the time of the sale. The price should be negotiated to reflect TVA's energy needs and alternative costs of generation available at that time. If agreement cannot be reached, DOE has the option of continuing operation for its use, or DOE may decommission the unit.

12.10.4.2 Cost Description of the Proposed Facility

ISA-2 and NRDC-60--Costs: The cost estimate in the FES supplement of \$3.525 billion represents the total of (1) plant investment--\$2.503 billion, (2) development--\$818 million, and (3) operating costs (less revenues) during the 5-year demonstration period--\$204 million. All costs are in year-of-expenditure dollars with no allowance for the cost of money. These values reflect the applicants' estimate of costs (with the exception of an adjustment of the operating cost component). The staff has evaluated the reasonableness of these estimates based on the following:

- Plant Investment Cost

With respect to the plant investment cost, the staff utilized the CONCEPT* computer code as an independent check on the reasonableness of the applicant's capital cost estimate. The code relies on trends in contributing cost factors, such as labor rates, labor productivity, and material and equipment prices, all as a function of location, time, and size of plant. The code's application to CRBR is problematic because CONCEPT is not geared toward making estimates for breeder reactors. Nevertheless, the results of this analysis do provide some insights into the reasonableness of the plant investment cost estimate used by the applicants.

The applicants' estimate of direct and indirect costs for consideration of the plant for operation in 1989 is

Base cost (1974), without escalation	\$1122.3 million
Escalation at 8% per year compounded	\$1198.1 million
Contingency allowance (including escalation)	\$ 182.8 million
Total	\$2503.2 million

*C. R. Hudson, "CONCEPT-5," ORNL, January 1979.

The conclusions from the staff's CONCEPT run are

- (1) The CONCEPT capital cost computer code estimated the cost for a 1200 MWe PWR for the Atlanta region. The total cost is \$691 million in 1974 dollars for the total of the direct and indirect costs without contingency allowance and with a craft labor content of 20 million manhours. For a 400-MWe PWR, the CONCEPT estimate is \$405 million in 1974 dollars with 11.2 million manhours. On a comparison basis, the CRBR is approximately 350 MWe and applicants' projection of cost is about \$1100 million in 1974 dollars. The CRBR nuclear steam supply system should be expected to cost as much as or more than a 1200-MWe PWR because containment diameters, vessel sizes, and heat exchanger surfaces are comparable or greater, design temperatures are higher, and the CRBR is a prototype with first-of-a-kind costs for the nuclear components. On the other hand, the CRBR balance of plant should cost no more than similar equipment for a conventional plant of equivalent electric output. Also, because approximately 25% of the plant investment cost is already sunk (as of 1982), a significant portion of the cost will not be subject to the cost uncertainties and escalation typically resulting in estimates for plants due on line 7 to 8 years in the future. Therefore, the plant investment cost used in the FES supplement appears to be of a reasonable magnitude.
- (2) The applicants have developed all costs in 1974 dollars and then escalated the annual cash flows at 8% per year to obtain total costs. The 8% per year rate is low for the 1974-82 period in comparison with the Handy-Whitman index of power plant construction costs which, since 1974, have increased at 9.8% per year for nuclear plants. Historically, nuclear power plant construction costs have increased at a real escalation rate of 1.5 to 2.4% per year greater than the general inflation rate, as measured by the Gross National Product Implicit Price Deflator. Assuming this relationship holds in the future, the applicants' 8% per year is consistent with a general inflation rate of 6% per year. Some estimates of the overall inflation rate for the 1980s and 1990s are (a) the California Energy Commission--8% per-year in the 1980s and 6.6% per year in the 1990s; (b) Blue Chip Economic Indicators--8% per year to 1985 and 6.1% per year thereafter through 1990; and (c) DRI, Inc.--8.5% per year in the 1980s and 6.0% per year in the 1990s. Based on these projections, it appears that the rate of 8% per year for power plant construction costs for 1982 through the completion of construction of the CRBR project is somewhat low.
- (3) The contingency allowance used in the FES supplement of approximately 7.9% includes the base direct and indirect costs and the escalation allowance. This allows for some uncertainty in the 8% per year escalation rate and allows for normal estimating errors for a well-defined scope of supply. However, in the staff's opinion, it may be somewhat low to allow for design and regulatory evolution such as that experienced by light water reactors during licensing and construction.

Development Cost

Approximately 85% of the total development cost of \$818 million has already been expended through fiscal year 1982. Consequently, it is not likely that this element of cost will contribute to cost overruns of any significance.

• Operating Costs (Less Revenues) During Demonstration Period

The applicants' estimate of initial nonfuel operation and maintenance (O&M) costs in 1988 is \$11.8 million/year in 1974 dollars. The staff has utilized the OMCOST* computer code to obtain an independent estimate of this cost. The updated OMCOST estimate for a light water reactor is approximately \$28 million/year in 1982 dollars, not including insurance costs and administrative and general expenses. The OMCOST estimate de-escalated to 1974 at 8% per year is approximately \$15 million, or, if de-escalated to 1974 at 10% per year, \$13 million. Because the CRBR is a prototype, the annual O&M costs should be no lower than for a comparable PWR, and probably higher. Therefore, the costs for O&M used in the FES supplement may be somewhat low. However, the staff's cost estimate used in the FES supplement assumes that revenues to be derived from the sale of CRBR energy during the demonstration period will be approximately one-half those assumed by the applicant. The conservatism should offset any underestimation of the cost component.

Based on the foregoing discussion, the staff acknowledges that some differences between the cost estimate contained in the FES supplement and the final realized costs are likely. However, there is no indication of any consistent bias in the elements of cost, and the staff concludes that the estimate of \$3.525 billion (in year of expenditure dollars) represents a reasonable measure of the overall cost of the CRBRP.

MIL-4--Need for Project: See response to OCRE-1

NRDC-55--Cost Estimates: See the response to IAS-2, above, specifically the discussion under Plant Investment Cost.

NRDC-84--Table A10.2: Table A10.2 is intended to present a summary of the environmental costs (impacts) of the proposed project, nothing more.

NRDC-85--Table A10.2: See response to NRDC-11.

NRDC-86--Monetary Costs: The applicants' estimated cost of the CRBR project of \$3.196 billion was officially submitted in May 1982 as part of Amendment XIV (Table 8.3 - p. 8.3-15) of the Environmental Report. The staff is not aware of any other official DOE estimate that has superseded this projection. A pro-rated share of the costs associated with the CRBR fuel cycle is included within the operating cost estimate provided in Table A10.3 of Section 10.4.2.2 of the FES supplement. Fuel cost factors considered include fuel fabrication, safeguards, and storage. Included in the plant investment cost is an allowance for the initial fuel load.

SC-4--Cost Parameters: Cost, as well as benefit, considerations cease in the year 1995 because there are no assurances that the CRBR will continue to operate beyond the proposed 5-year demonstration period.

*M. L. Myers, "A Procedure for Estimating Nonfuel Operation and Maintenance Costs for Large Steam-Electric Power Plants," ORNL, January 1979.

Decommissioning is discussed in detail in Section 10.2.4 of the FES supplement; it is also discussed in Section 10.4.2.2 in connection with the cost-benefit summary.

Operating costs for CRBR during the demonstration period include a prorated share of the costs of safeguards and fuel storage.

12.10.4.3 Benefit-Cost Summary

GF-2--Cost-Benefit Analysis: The staff recognizes a potential for unanticipated costs, from various sources, associated with the CRBR project. To some extent these are reflected in the cost calculations provided in the FES supplement. For example, a contingency allowance and relatively low performance (capacity factor) during initial operation are included in developing cost estimates. It is of course possible that additional unanticipated costs will arise, but the staff views this as speculative. Further, even if an allowance were made for such contingencies, it would not alter the conclusions of the cost benefit review. This review was limited to those alternatives that will meet the programmatic objectives of the LMFB program; thus, the staff has considered only design and site alternatives to Clinch River. Consideration of additional unanticipated costs would be invariable relative to all these alternatives.

MIL-1--Cost-Benefit Ratio: The FES supplement concludes that the proposed action will accomplish the LMFB program objectives in the most effective fashion. Alternatives that are not consistent with these program objectives were not considered in the cost-benefit discussion as they are viewed as being outside NRC's review responsibility. The projected generation of electricity by the CRBR has consistently been identified as a minor secondary benefit and as such will have little consequence on the cost benefit discussion. Uncertainties regarding the future performance and reliability of the breeder technology in a commercial environment do exist, and the operation of the CRBRP would provide information benefits in these areas.

NRDC-87--Benefit-Cost Summary: The staff contends that the text of the FES supplement provides ample justification for these conclusionary assessments. The staff acknowledges that it would be preferable to adopt one unit of measure such that all impacts could be directly comparable. However, in the real world, this is difficult to achieve and, if accomplished, would necessitate countless subjective evaluations. On balance, there is no assurance that such an approach would produce conclusions that are any more scientific or accurate than those already provided by the staff.

12.11 Discussion of Comments Received on the Draft Environmental Impact Statement

12.11.1 Summary and Conclusions, Introduction, and General Comments

12.11.1.7 Site Suitability

NRDC-88--Meteorological Data: There is no discussion of meteorology in Section 11.1.7 nor in Section 11.7.1, which is referenced in Section 11.1.7. It should be noted that meteorological data collected using the system described in Section 6.1.3 of the supplement (which were collected during the period

February 17, 1977 through February 16, 1978) have been utilized by the staff in its June 1982 update of NUREG-0786.

12.11.2 The Site and Environs

12.11.2.15 Frequency of Heavy Fog

NRDC-89--Heavy Fog: The applicants conservatively estimate that fogging or icing conditions resulting from cooling tower operations will occur on approximately 40 days per year, as stated in Section 5.3.3 of the FES. It should be noted that most of these fogging occurrences would coincide with natural fog because the atmospheric conditions conducive to natural fog are also conducive to the formation of fog resulting from cooling tower operation. The number of hours per year of fogging resulting from cooling tower operation on U.S. 40 and at ORNL are listed in Section 5.3.3 of the FES. The potential interaction of the ORGDP with the CRBRP plume when winds are from the north is listed on ER page A1-95 in response to staff question A1; potential interaction expected is approximately 2% of the time. The plumes from the ORGDP should be much longer than those from the CRBRP. The number of hours of fog expected on Route 95 as a result of CRBRP cooling tower operation is approximately 4 hours per year (in all probability coinciding with naturally occurring fog). There probably would be no impact from the CRBRP cooling tower releases on Bear Creek Road because any visible cooling tower plume would intersect with Chestnut Ridge, be diverted by the ridge, and not reach Bear Creek Road on the other side of the ridge.

12.11.2.16 Unfavorable Meteorology

NRDC-90--Atmospheric Dispersion: The key issue is whether the potential atmospheric dispersion conditions at the Clinch River site are such that the CRBRP can be licensed at this site. Because nuclear power plants have been deemed to be licensable with similar or poorer dispersion factors than those expected at the Clinch River site, the staff concludes that the Clinch River site is licensable.

The meteorological assumptions used in analyzing the consequences of accidental releases are discussed in detail in the June 1982 update of the Site Suitability Report (NUREG-0786).

12.11.4 Environmental Impacts Due to Construction

12.11.4.10 Disposal of Dredged Material

EPA-17--Dredged Sediment: This commentor states that (1) the dredged material should be disposed in an area above the floodplain and (2) radiological monitoring of the dredged material should be established. The applicants have agreed to the following: (1) to place the dredged sediment above the floodplain; (2) to survey the dredged sediment as it is placed in the disposal area; and (3) to place a cover of soil over the dredged material. Before the CRBRP site is decommissioned, the NRC staff will review the decommissioning plans for the CRBRP to ensure that they meet all applicable Federal regulations.

12.11.6 Environmental Measurement and Monitoring Programs

12.11.6.7 Enforcement of Monitoring Programs

NRDC-91--NPDES: Part II of the proposed NPDES permit provides for self monitoring, submission of reports and noncompliance notifications, and other requirements to ensure compliance with permit limitations and requirements. Additionally, periodic compliance inspections will be conducted by EPA and/or State of Tennessee personnel to verify compliance. As noted in Part II.A.1, Page II-1, violations are subject to penalties as provided in Section 309 of the Clean Water Act, including fines of up to \$25,000 per day and/or imprisonment. Discharge monitoring reports as well as plans, reports, and other data and information are available for public inspection at EPA and state offices.

12.11.7 Environmental Impacts of Postulated Accidents

12.11.7.12 Seismic Considerations

NRDC-92--Safe Shutdown Earthquake: The staff does not review the safe shutdown earthquake (SSE) for a nuclear power plant in the FES but in the SER. The applicants have proposed that an earthquake of maximum Modified Mercalli intensity VIII, characterized by a horizontal ground acceleration of 0.25g, anchoring a Regulatory Guide 1.60 spectrum, is appropriate for CRBRP structural design.

It is the staff's position that the controlling earthquake for the seismic design of nuclear power plants in the Southern Valley and Ridge tectonic province (the tectonic province in which CRBRP is located) is the occurrence of a Giles County, Virginia 1897-type earthquake (maximum Modified Mercalli intensity VIII, magnitude $m_b = 5.8$) in the site vicinity. Based on its reviews of site-specific response spectra studies conducted for other nuclear power plants in the Southern Valley and Ridge tectonic province (Sequoyah, Watts Bar, and Bellefonte), the staff concludes that a Regulatory Guide 1.60 response spectrum with a zero period anchor of 0.25g is a conservative representation of the vibratory ground motion on rock for the controlling earthquake.

12.11.7.13 Sodium Behavior

EPA-3 and -18--Sodium Aerosols in the Environment: The staff agrees with the comment that additional information is needed in order to take realistic credit for the enhanced fallout of the atmospheric releases as a result of the tendencies of the sodium aerosols to agglomerate. Such considerations would in general be expected to reduce the estimated offsite risks.

12.11.7.16 Emergency Preparedness Plans

CWE-1--Socioeconomic Costs: The risk of economic impacts reported in Appendix J is based on the economic model described in Section 12 of Appendix VI of the RSS (WASH-1400). It includes the consideration of the cost of decontamination of the impacted property, the decrease in value of the interdicted property, the value of the goods that might be condemned, the cost of managing possible site evacuation, and the cost of temporary relocation of the evacuees. For details of the economic model, see WASH-1400.

The staff has evaluated the doses at the nearby facilities as a result of a hypothetical core disruptive accident at the CRBR site and has found that, although the stated facilities may have to be evacuated, the evacuation of facilities such as ORGD (K-25), ORNL, and the Y-12 plant would not have any significant impact on national energy supply. The finding regarding the impacts of such evacuation on national security would have to be made by the Department of Energy.

DHHS-4--Emergency Preparedness Plans: The Commission's regulations and guidance address those elements contained in the comments received from the Department of Health and Human Services pertaining to emergency preparedness. The staff's evaluation of the CRBRP emergency plan, including the emergency response facilities and the arrangements between the applicant and state and local governments and agencies, will be presented in the CRBRP Safety Evaluation Report during the operating license review for compliance with the criteria specified in NUREG-0654/FEMA REPI (see also the response to OCRE-8).

OCRE-8--Protective Actions: 10 CFR 50.47 states, in part, that the onsite and offsite emergency preparedness plans for nuclear reactors must meet specific criteria in NUREG-0654. With the exception of the issue of economic impact, the onsite and offsite plans address the comments pertaining to emergency preparedness received from the Ohio Citizens for Responsible Energy (OCRE). CRBRP benefit-cost considerations are addressed in Section 10.4 of the FES.

12.12 Appendices

12.12.D Environmental Effects of the CRBRP Fuel Cycle and Transportation of Radioactive Materials

12.12.D.1 Introduction

NRDC-46 and -93--Fuel Availability: NRDC previously raised the issue of the availability of fuel for the CRBRP as Contention 17. The Hearing Board considered this contention and on April 14, 1982 ordered that the contention be denied as a matter of law. The Board stated: "This contention concerns a policy or programmatic issue which, in accordance with the guidelines set forth by the Commission in its earlier decision, is outside the permissible scope of this proceeding. The contention involves questions of DOE policy and future actions which go wholly beyond the proper issues relevant to this particular plant."

Accordingly, because this question is outside the scope of this proceeding and goes beyond the proper issues relevant to the CRBRP, the staff does not believe that an answer is required.

NRDC-94--Dose Consequences of Plutonium Releases: NRDC states that the staff has underestimated the dose consequences associated with plutonium release, because of (1) the staff failed to utilize the appropriate plutonium isotopic concentrations associated with high burnup of light water reactor fuel and recycled mixed oxide and (2) the underestimation of the related emissions.

With regard to the plutonium isotopic concentration that was used for the overall fuel cycle assessment, DOE specifically provides the isotopic concentration of the feed plutonium in the core and states: "The isotopic split is similar

to FFTF-grade plutonium." The staff has used the DOE-specified plutonium composition in its detailed review of the CRBR fuel cycle. In addition, the staff has performed a sensitivity analysis of fuel cycle options (Appendix D, Section D.2.4.7) to cover a range of variations from the simplified fuel cycle projected by the applicants to assess qualitatively the effects of such alternatives as variations in plutonium isotopic composition, etc. However, the application and Environmental Report have been based upon the use of stockpile plutonium as the initial core. Therefore, the NRDC hypothetical scenario that the initial core plutonium is to be obtained from commercial plutonium sources rather than the DOE stockpile has not been considered as an alternative in the NRC evaluations.

The plutonium loading of the CRBRP core used by the staff and reported in Table D.1 on page D.2 of Appendix D is based upon information provided by the applicants in the ER. ER Section 3.8.1.1, Core Assemblies of the ER, states: "The 36-inch core length of 156 fuel elements contains 5.2 metric tons of heavy metal (fertile and fissile plutonium plus uranium) with a plutonium enrichment of 33.2 per cent." The same information is provided in Section 5.8.3, Commitment of Fuel Resources. These data translate to the initial core containing 1.7 MT of Pu, which is in excellent agreement with the value of 1.71 MT in Table D.1 of the staff's statement.

With regard to the overall fuel cycle to be considered by the staff, in Amendment XIV to the ER, the applicants provided the specific fuel cycle that is planned for handling CRBR fuel. This is the only valid basis that the staff has for its detailed fuel cycle analysis.

12.12.D.2 Environmental Considerations

CEC-4--Waste Handling: From the section in the CEC comment letter entitled "The Supplement Fails to Adequately Assess Unresolved Waste Management Issues", the staff has identified the following specific comments:

- (a) The NRC staff identifies final site selection and "establishment" of facilities as the only unresolved issues in handling CRBRP wastes and gives no suggestion that there will be any difficulty at all in resolving these issues.
- (b) The supplement does not give any specific plans for handling CRBRP high-level wastes, stating only that they will be stored indefinitely on site without indicating the differing impacts and problems between burial and onsite storage.
- (c) There is no mention of the NRC's ongoing "waste confidence" proceeding in the the supplement.
- (d) The supplement's cursory conclusion on socioeconomic impacts of CRBRP wastes does not present the analysis required by NEPA. The supplement is completely inadequate in its analysis of institutional issues.
- (e) The status of EPA standards and whether DOE's program will meet the standards are issues being debated in NRC's waste confidence proceeding and should have been mentioned in the supplement.

- (f) The supplement does not identify the primary sites for a repository that are under consideration.
- (g) There is insufficient discussion of the CRBRP onsite storage program and any associated impacts.

The staff responses to these comments are:

- (a) The statement the commentor refers to is

Both the Federal high-level waste repository and the specific commercial low-level waste disposal facility that would be used for management of CRBRP fuel cycle wastes are not established at this time.

The statement means that the facilities identified have not been located, constructed, or selected at this time, and that such activities are not related to the cost/benefit balance for CRBRP.

- (b) The solid wastes referenced on page 3-14 of the Draft Supplement are not high-level wastes as the commentor states, but are low-level wastes. All low-level solid waste, except metallic sodium, will be shipped to a licensed burial site in accordance with NRC and Department of Transportation regulations. Metallic sodium will be stored on site. Metallic sodium wastes will constitute only a minor fraction (i.e., ~1%) of the total low-level waste (LLW) volume generated by operating CRBRP (see Table D.9).

Appendix D outlines impacts associated with burial of LLW in a commercial facility. In addition, the entire LLW volume from CRBRP is an insignificant (0.2%) portion of currently available LLW disposal capacity.

- (c) The high-level waste confidence proceeding is, as the commentor stated, a proceeding to assess generically the degree of assurance now available that radioactive waste can be safely disposed of to determine when such disposal or offsite storage will be available, and to determine whether radioactive wastes can be safely stored on site past the expiration of existing facility licenses until offsite disposal or storage is available. The staff is fully aware that any Commission decision in the waste confidence proceeding would be applicable to the CRBRP. Furthermore, the staff has not evaluated the national waste management issue in the CRBRP FES. The staff has simply concluded in most instances that the contribution of CRBRP wastes to the total environmental impact resulting from the disposal of commercial LWR wastes is quite small and insignificant by comparison. The staff does not consider the FES the appropriate forum to discuss the much broader issues being considered in the waste confidence proceeding.
- (d) NUREG-0139 (Supplement No. 1) has adopted by reference the detailed analysis of DOE 1980b (pursuant to CEQ guidelines, Section 1506) regarding socioeconomic impacts of a geologic repository. In addition, employment figures for the SAF line (peak construction force ~ 250 peak operational force ~ 100) and the DRP (peak construction force ~ 300, peak operational force ~ 60) have been provided. An analysis of any economic effects associated with these two facilities (i.e., changes in income and expenditures, including demands for services) is not believed to be warranted

given the small increase in population and the fact that these facilities would be sited at either Hanford or Oak Ridge, which are developed areas.

The staff defines how it views socioeconomic impacts (i.e., changes in population during facility construction and operation and any resultant changes in income, expenditures, and demands for services). This is different from institutional issues that address such aspects as

- the role of states in the siting process
- Congressional legislation (or the absence of its) on waste management matters
- the need for human institutions in the long term

These types of institutional issues with regard to waste disposal need not be considered in assessing the environmental effects resulting from the construction and operation of CRBRP.

- (e) As part of the process of licensing a repository, NRC will require that specifications of 10 CFR 60 be satisfied (at a minimum) in order to ensure compliance with EPA limits. In addition, the wastes from CRBRP will constitute approximately 1/100th of the inventory in a geologic repository (based on conceptual repositories as described in DOE 1980b). This leads the NRC staff to conclude that any releases from a repository (that are attributable to CRBRP) should be insignificant and small by comparison (for instance) to the curies of increased natural radioactivity during operation of a repository.
- (f) It is the staff's view that it is not necessary to identify specific repository sites and that identifying the present status of DOE's repository site-selection program would not add to the discussion of waste management impacts. Using the analysis in DOE 1980b as a basis, impacts associated with the repository disposal in four geologic media (salt, basalt, granite, and shale) are presented. As such, the reader is provided with an estimate of the range of impacts that might be observed if the repository were sited at the Hanford Reservation; the Nevada Test Site; in Texas, Mississippi, Utah, or Louisiana; or in a granite formation in the east or upper Midwest.
- (g) The wastes the commentor refers to on page 3-14 of the supplement are metallic sodium wastes collected from fuel-handling equipment. As shown in Table D.7, these canisters are estimated to total 60 over the lifetime of the CRBRP. This is very small by comparison to the number of other LLW canisters which the CRBRP is projected to generate (12,000-13,000) and which would be stored on site for some period prior to shipment to a commercial LLW burial ground. This procedure of on site storage of LLW prior to shipment is essentially the existing practice at LWRs with regard to storage and shipment of LLW to Barnwell, South Carolina; Beatty, Nevada; or Hanford, Washington. The practice results in little or no impact on the environment.

The text of the supplement is not explicit regarding handling of metallic sodium wastes because at this point it is the NRC staff's understanding that DOE has not determined what procedure will be used for ultimate disposition of metallic sodium wastes.

CEC-5--Tables D.2 and D.3: The analysis performed in the Draft Supplement was not based on 10 CFR 51.20 Table S-3.

DOE-Y--Table D.16: In Table D.16, for "Spent Blanket Assemblies" person-rem should be 4.9; for "HLW," the value should be 1.2 person-rem. This changes the total for "Transport Workers" to 25 person-rem and the total for "General Population and Transport Workers" to 30 person-rem. Appropriate changes in the text in Section 5.2.4.5, Appendix D.2.4.6, and Table D.17 also have been made.

NRDC-95--Retention Factors: The staff cannot find any basis to determine retention factors for fuel reprocessing plants from the data presented in the document referenced by NRDC, DPSPU-75-25-1 (which is a 1976 document). Ashley and Zeigler have presented data for releases only. Other data from which retention factors could be deduced are noted as classified in the document. For retention factors, the staff has relied, to a degree, on publicly available guides and standards, which are based on acceptable and achievable practices. The applicants have committed in the ER to utilizing NRC Regulatory Guides* and EPA standards or their equivalent for the Developmental Reprocessing Plant (DRP). The retention factors used by the staff are considered to be somewhat conservative estimates based on likely performance. See also comments to NRDC 94.

The concept of zero liquid effluents is a DOE design concept for the DRP, not an assumption by the NRC. Further, this approach has been the basis for the design of recently proposed plant for fuel reprocessing. Therefore, the NRC staff finds no basis for adding a liquid effluent to the plant design concept proposed by DOE.

NRDC-96--Time of Interest: The term "time frame of interest" for CRBRP used by the staff in this section refers to the several decades of proposed operation of the CRBRP.

NRDC 97--Isotopic Concentrations and HEPA Filter Cleanup Factors: This NRDC comment seems to center about the belief that isotopic concentrations and HEPA filter cleanup factors used in Section D.2.1.2 (core fuel fabrication) of Appendix D are nonconservative assumptions.

With regard to plutonium isotopic concentrations, DOE specifically provides the isotopic concentrations of the feed plutonium in the core and states: "The isotopic split is similar to FFTF-grade plutonium." The staff has considered the DOE-specified plutonium composition in its review of the CRBR fuel cycle and has also considered the use of LWR high-burnup plutonium, which was used in DOE's environmental review of the Fuels Materials and Engineering Facility (FMEF). The staff assessment is based on a combination of the worst conditions of both assumptions.

*Regulatory Guides 3.18, "Confinement Barriers and Systems for Fuel Reprocessing Plants"; 3.20, "Process Offgas Systems for Fuel Reprocessing Plant"; 3.26, "Standard Format and Content of Safety Analysis Reports for Fuel Reprocessing Plants."

With regard to cleanup factors, cleanup factors applicable to individual filters or banks of filters in series are not routinely measured during operations involving plutonium for a number of reasons such as widely varied operations, range of source concentration, etc. Therefore, NRC has no directly obtained quantitative values of annual cleanup factors for the operations mentioned. However, such factors are determined for systems before the filtration system is used. Guidance to NRC licensees and DOE contractors similarly advises that HEPA filter systems should be tested after filter installation using a "cold DOP" test.* Acceptance should be based on an efficiency of 99.95% or better. A system with three filters in series (as planned for the SAF line) that passes this test will have a calculated cleanup factor of 1.25×10^{-10} . For these reasons the staff feels that derating a filtration system by a factor of 100 (cleanup factor 1.25×10^{-8}) is a sufficiently conservative basis for estimating gaseous effluent quality.

NRDC-98--Reprocessing CRBR Spent Fuel: The staff disagrees that the Savannah River plant would be appropriate for estimating the environmental effects of reprocessing spent CRBRP fuel. DOE has indicated that the DRP is the likely candidate for reprocessing CRBRP spent fuel. The NRC staff has evaluated the environmental effects based upon the proposed design conditions of this most likely alternative. Further, based on the DOE commitment to current DOE, EPA, and NRC standards and guides, the staff believes that the estimates are reasonable and, in some instances, conservative.

NRDC 99--Alternative Reprocessing Plants: There would have to be some physical alteration of either the Savannah River or Hanford plants for CRBR spent fuel reprocessing. While DOE has presented very little information as to the specific provisions in the event that CRBR fuel would be processed at these sites, it is the staff's understanding that these design parameters for the DRP would be applied to any of the DOE alternatives. These alterations could include provisions such as removal of krypton-85, etc. It is expected that further environmental analysis of such changes would be performed by DOE if such changes to the fuel cycle were proposed.

The staff reference on page D-14 to impacts from releases being "very small" was drawn from the DOE (ERDA) documents cited in the paragraph. The statement is factually correct from that perspective.

NRDC-100--Waste Management Impacts: In its assessment of the impacts associated with the storage and disposal of radioactive wastes that would result from the CRBRP fuel cycle, the staff considered wastes produced by the blanket fuel fabrication plant, the core fuel fabrication plant, the reactor plant, and the proposed fuel reprocessing plant. These facilities represent all of waste streams from the CRBRP fuel cycle. The staff sees no reason to examine the solid waste streams associated with the Savannah River plant F separations area, which is a defense establishment.

*Regulatory Guide 3.12, "General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants; DOE Manual Chapter 5480.1A, "Environmental Protection, Safety, and Health Protection Program for DOE Operations," August 13, 1981.

As part of the process of licensing a repository, the requirements of 10 CFR 60 will have to be satisfied (at a minimum) to ensure that EPA limits will be achieved. Because CRBRP wastes constitute such a minor fraction of the overall repository inventory, it is the staff's view that any releases from the repository which could be attributable to CRBRP would be very small (i.e., approximately 1% based upon the relative quantity of CRBR fuel to repository inventory).

Table 5.4.9 in DOE 1980b (see the Reference section) displays annual releases of naturally occurring radioactivity to the air from construction of a geologic repository. The nuclide values in Table 5.4.9 were added together for each of the four geologic media. This resulted in total releases ranging from 5.9×10^{-3} Ci/yr for a salt repository to 53 Ci/yr for a granite repository. Because CRBRP wastes constitute about 1/100th of the repository inventory, releases attributable to CRBRP on a pro rata basis are 6×10^{-5} Ci/yr for a salt repository and 5×10^{-1} Ci/yr for a granite repository.

DOE 1980b estimated that the 70-year accumulated whole-body dose to a regional population from annual releases of "radon and decay products" for each of the 7 years of mining would range between 7×10^{-3} person-rem (for a salt repository) to 100 person-rem (for a granite repository). Again, applying a factor of 1/100 to these doses to account for the contribution of CRBRP wastes to the overall inventory yields doses ranging between 7×10^{-5} person-rem (for a salt repository) and 1 person-rem (for a granite repository).

The text in the supplement will be modified to reflect that the doses are 70-year accumulated doses (and not annual doses). The dose that the regional population is projected to receive from background radiation has also been changed to account for 70 years of exposure. (See also response to NRDC-99.)

NRDC-101--Dose Commitments from Fuel Reprocessing: This comment raises four points: (1) "the staff should explain more fully the underlying assumption behind the calculations, (2) the staff should present estimates of the dose to the bone surface from exposure to radioactive effluents from the fuel reprocessing plant because 'the bone surface dose is controlling with respect to the CRBR site suitability source term analysis,'" (3) the source term used for the fuel reprocessing plant is too low by a factor of 50 to 600; and (4) the dose to the bone surface is about 4 to 5 times higher than the dose to the bone.

In regard to the first point, the staff has provided NRDC with its detailed calculations of doses from exposures to radioactive effluents from the fuel reprocessing plant (see Staff's Responses to Interrogatories 14-18 of the NRDC's 27th set of Interrogatories). The staff included the pertinent reference in the Draft Supplement, rather than the detailed calculations, because the primary emphasis in the supplement should be on describing the potential impacts, rather than the details of the calculations.

In regard to the second point, it should be noted that the source term for the fuel reprocessing plant is quite different than the source term used in evaluating postulated design-basis accidents for the purpose of site suitability for CRBRP. Most of the estimated doses from exposure to radioactive effluents from the fuel reprocessing plant were due to exposure to tritium and carbon 14. Because tritium and carbon-14 tend to be dispersed uniformly throughout the body, and because the risk to the bone surface is small in comparison to the

risk of irradiation of the total body, the staff did not present estimates of the dose to the bone surface.

For response to the third point, see the responses to NRDC-94 and -99 above.

In regard to the last point, it should be noted that dose conversion factors for the bone surface may or may not be greater than the dose conversion factors for the bone, because dose conversion factors are specific for a particular radionuclide (see also response to second point above).

NRDC-102--Dose Commitments from Reprocessing: The cooling time of spent CRBR fuel has no effect on the staff's calculations of doses for normal transportation conditions. The staff's basis for its calculations was that any package used in transportation would meet the conditions of DOT regulations, 49 CFR 173.393, by provision of adequate shielding. Thus radiological exposures would be limited to 2 mrem/hr at any normally occupied position in a transport vehicle and 10 mrem/hr at any point 2 m from the vertical planes projected from the outer edges of an open transport vehicle. This is a very conservative (high-side) basis because the staff did not take credit for any reduction in exposure below these limits, but assumed that the dose rate was the level permitted by the regulations.

With regard to waste management impacts, the footnote in Table D.4 refers to values which would be negligible in comparison to releases of "radon and decay products" during repository construction. It is the staff's view that the footnote would be clearer if it were reworded as follows:

...means not reported, or the staff believes these values would be negligible by comparison to other releases reported under waste management.

Additionally, the repository system will be licensed to comply with, as a minimum, the criteria specified in 10 CFR 60. As a result, any releases from CRBRP wastes in a repository would be very small in comparison to the 0.5 Ci/yr estimate for release of radon and decay products that might occur during repository mining operations.

SRIC-1--Transport Vehicles: The description of transport vehicles is irrelevant to the analysis of the environmental impact of material transportation. No credit was taken for the added safety provided by the safeguards features of the vehicle.

The packaging used must be demonstrated to meet the requirements of 10 CFR 71. It should be noted that no Type B package has ever released any of its contents as a result of a transportation accident. Package design criteria, coupled with thorough quality assurance requirements, provide confidence that the probability of a Type B package releasing its contents in a severe accident is low.

The FES is concerned only with the impact of transporting materials relating to the CRBRP, not with wastes from commercial and military sources.

SRIC-4--West Valley Releases: The staff is fully aware of the releases resulting from operation of the West Valley reprocessing plant. That plant was designed to have controlled releases of low-level radioactivity in liquid

effluents. However, recent design concepts have eliminated releases of radioactivity in liquid effluents. The most likely candidate for reprocessing the spent fuel from the CRBRP is the Development Reprocessing Plant, which excludes a liquid pathway.

The meteorological model used by the staff for estimating the radiological impact of releases of radioactivity is indicated on page D-30, Section 4.2.4.3. The released radioactivity is subject to the physical laws of diffusion and advection which have been utilized and applied for many years in the nuclear industry. For example, one useful reference is "Meteorology and Atomic Energy 1968," David H. Slade, Editor, U.S. Atomic Energy Commission, July 1968. Because the releases considered here by the staff will occur over several years, it is highly likely that the dispersion will be in all directions from the plant, but primarily in the predominant wind directions.

WAL-2--Use of Already Produced Depleted Uranium: The comment questions the validity of applying no environmental impacts to the CRBR fuel cycle for the use of already produced depleted uranium. The DOE has on hand thousands of tons of depleted uranium tails as the result of its operations to produce enriched uranium for other programs. This stockpile was produced independent of any CRBRP requirements, and the environmental effects from its production are attributable to those programs. Thus, the use of this uranium for the CRBR program has no effect on the quantity of uranium mined or milled in the past or to be mined or milled in the future. The uranium used for the CRBRP will not have to be replaced in the stockpile because it is not a commodity that is otherwise in demand. Thus, it is entirely valid that no environmental impact be ascribed to the CRBR fuel cycle for the use of the depleted uranium withdrawn from the DOE tails stockpile.

With regard to the availability of plutonium, the DOE has stated that the plutonium to be used for the initial loadings of the CRBRP will come from existing DOE stockpiles. Thus, it also is available as a result of existing programs and has not or will not be produced just for the CRBRP. Because it is material on hand from other programs, it does not create any environmental effects attributable to the CRBR program.

12.12.E Safeguards Related to the CRBRP Fuel Cycle and Transportation of Radioactive Materials

12.12.E.1 Introduction

CSE-1--Diversion of Plutonium: CSE indicates a concern about the risks of plutonium diversion from the CRBR fuel cycle.

The staff has reviewed DOE's safeguards proposals for the CRBRP, including all fuel cycle and transportation activities. In the ER the applicants made a commitment to apply extensive safeguards measures to CRBR activities. The staff found that these measures are appropriate for the activities in question and that the requisite technologies will be available. Thus the staff concluded that, based on DOE's planned safeguard measures, the risks of plutonium diversion are acceptably small.

CSE is in error about the quantity of plutonium produced by the CRBRP. The CRBRP will have a plutonium throughput of about 1,000 kg (2,000 lb) per year

and will produce about 150 kg (325 lb) per year in excess of its needs, not 2,000 - 4,000 lb as noted in the CSE comment.

MS-2--Safeguards: The staff believes that the consequences of a successful act of sabotage or theft could be severe and has stated this in the FES. The staff's approach to this environmental review has therefore been to evaluate the potential effectiveness of DOE's safeguards proposals, and the staff has concluded that the probability of a successful act of sabotage or theft is low. The staff believes that the discussion of DOE's proposals in the FES is sufficiently detailed for an environmental review of the CRBR fuel cycle.

The staff has previously considered the societal effects of safeguarding a commercial plutonium industry. In updating the response to a comment received on the DES (see p. 11-21), the staff referenced the analysis of societal impacts in NUREG-0414, "Safeguarding a Domestic Mixed Oxide Industry Against a Hypothetical Subnational Adversary." NUREG-0414 concluded that the measures required to safeguard a mixed oxide industry are not likely to have severe societal effects.

NRDC-103--Evaluation of Safeguards Proposal: The commentors have objected to the criteria used by the staff to assess DOE's safeguards proposals. The comment suggests that the criteria are too weak, and should be strengthened by substituting "high" assurance for "reasonable" assurance.

The staff believes that the safeguards review in Appendix E is of appropriate depth and scope for the construction permit phase of the facility under licensing review and for facilities that will not be subject to NRC licensing review but that have the potential to contribute to the environmental effects of a facility undergoing the licensing review. The purpose of this licensing review is to make sure that the applicants understand the relevant NRC regulations and have anticipated all of the major potential environmental impacts. In the case of safeguards, the staff's approach has been to assess the general systems proposed by DOE to determine if they are technically reasonable, if they are applicable to the facilities in question, and if they are roughly comparable to the measures NRC requires for its licensees. The criteria in Appendix E were selected to reflect this approach.

The CRBRP will ultimately be reviewed by the NRC for an operating license. At that stage, the safeguards system for the reactor will be assessed in more detail and compliance with specific NRC requirements, some of which have the objective of providing a "high" assurance, will be determined.

For other facilities of the CRBR fuel cycle, the extant review will likely be the only NRC review.

OCRE-4--Workability of Safeguards: This comment contends that the safeguards discussed in Appendix E are of unproven workability. The staff believes that this statement is inaccurate. Most of the safeguards measures proposed by DOE are similar to systems currently employed at other DOE nuclear facilities or at comparable NRC-licensed facilities. All of DOE's proposals for intrusion detection, access control, alarm response, and physical inventory systems can be implemented with currently available technologies. Some of DOE's proposals for rapid material accounting in the reprocessing plant appear to require measurement technologies that have not been extensively employed in currently

operating facilities. The staff recognized, however, that significant progress is being made in safeguards measurement technologies and concluded that in the time required to plan, design, and build the Developmental Reprocessing Plant it is highly likely that the necessary technical refinements will be available.

OCRE also contends that an effective safeguards systems for the CRBRP would have an adverse impact on civil liberties and that this issue has not been considered by the staff. In updating the response to a comment received on the DES (see p. 11-21), the staff referenced the analysis of societal impacts contained in NUREG-0414. NUREG-0414 concluded that the measures required to safeguard a mixed oxide industry are not likely to have severe societal effects. Thus the staff believes that this comment has already been addressed and does not require a further response.

OCRE has also postulated that plutonium produced by the CRBRP will be used for U.S. nuclear weapons. The staff is not aware of any plans to use plutonium produced by the CRBRP for U.S. nuclear weapons. Further, the staff does not believe that the use of the CRBR fuel cycle would be an efficient or effective way to produce weapons-grade plutonium.

12.12.E.2 Safeguards Design-Basis Threats

NRDC-104--Threat Comparison: The staff believes that the statement made in Section E.2.1 "...safeguards programs designed in accordance with DOE's threat guidance will provide a level of protection against theft and sabotage at least as high as that provided by programs designed in accordance with NRC's design basis threats" is correct. Because DOE's threat guidance is classified, it is not possible in this assessment to perform an item-by-item comparison with NRC's design-basis threats.

NRDC-105--Design-Basis Threats: Section E.2.2 is a paraphrasing of the NRC's design-basis threat definition in 10 CFR 73.1(a). The design-basis threat definition does not contain the phrase "with a high degree of assurance"; in fact, this phrase is not contained in any part of 10 CFR 73.1. The chapter on general performance objectives for physical security systems, 10 CFR 73.20, states that the licensee must establish a physical security system that "will have as its objective to provide high assurance that activities involving special nuclear material are not inimical to the common defense and security."

12.12.E.3 DOE Safeguards System for Plutonium Conversion

CEC-2--Diversion and Sabotage: See comments in Section 12.7.3.

NRDC 106--Physical Security System: The depth of the staff's review of DOE's safeguards proposals has been appropriate for an environmental impact review, as discussed in response NRDC-103. Bearing in mind that the central purpose of the NRC licensing review is to consider a license for the CRBRP, not the fuel cycle activities, the staff believes that the fuel cycle review has been sufficiently detailed.

NRDC-107--Material Control and Accounting System: The staff agrees with the commentors that adequate material control and accounting (MC&A) is important for a safeguards system. The staff accepted as reasonable DOE's statement that for the conversion plant the limit of error on a 2-month inventory difference

would be less than 0.5% of throughput. The basis for the staff's position is the operating experience of NRC licensees with similar facilities. NRC regulations require fuel cycle licensees (except some portions of reprocessing plants) possessing formula quantities of strategic special nuclear material* to perform material balances every 2 months with measurement system limits of error of not more than 0.5% of throughput. Rarely do the licensees in question have difficulty meeting this requirement.

In addition to physical inventory accounting system, DOE has stated in the ER that the conversion facility will be equipped for unit process accounting. The NRC does not at present have any requirements for such a system, but the staff views DOE's proposals in this area as a useful supplement to the more conventional parts of the DOE safeguards plans. On p. 5.7-45 of the ER, DOE states: "on line unit process accountancy data and bulk/chemical analysis data will be continuously fed to a computer and analyzed for abrupt and protracted losses." An MC&A system based on computer-accessed, online instrumentation should be able to provide timely detection of theft or loss. The staff believes that it is technically feasible to implement a computerized data handling system that will function reliably and provide MC&A information with acceptable timeliness. Several nuclear fuel cycle facilities have experience with such systems. In the TA-55 plutonium facility at Los Alamos, DOE has demonstrated a comprehensive unit process accounting system with encouraging results (Auguston, 1978). In sum, while the staff recognizes that there is relatively little operational experience with unit process accounting, it appears that the components are sufficiently developed to permit its implementation in the CRBR conversion process as a supplement to DOE's other safeguards systems.

The commentors question whether DOE will have the funding and desire to actually implement these advanced safeguards systems when the time comes. The NRC staff has been assured that the safeguards descriptions in the ER represent DOE's intentions with regard to the CRBR fuel cycle.

NRDC-108--Plutonium Conversion Safeguards: In Section E.3.4 the staff concluded that DOE's proposals for safeguards for the conversion facility meet the three assessment criteria of Section E.1. The bases for this conclusion were (1) that DOE's proposals include all essential safeguards elements for this sort of facility and, (2) that the performance goals specified by DOE appear to be technically achievable and comparable to the requirements that NRC would impose on its licensees. The reasonableness of the MC&A performance goals is discussed in NRDC-107.

The issue of "high" versus "reasonable" assurance is discussed in NRDC-103.

The staff did not attempt for the purposes of this review to establish a quantitative criterion for "timely" detection. Physical security systems usually provide almost instantaneous detection of intrusions or unauthorized activities. As discussed in NRDC-107, the unit process accounting system for the conversion facility will be based on computer-accessed online data. Such systems can be designed to detect losses within periods of a few days or even hours. The staff believes that the integrated combination of physical security, unit process accounting, and the material controls required by DOE Orders can

*See 10 CFR 70 for exact definitions of terminology.

provide a high probability of preventing successful thefts and detecting removals from process shortly after they occur (within days or hours).

Section E.3.4 contains the statement that the conversion facility would be provided with communications systems adequate to facilitate effective response actions by both onsite and offsite forces. The staff did not intend to imply, as the comment suggests, that offsite forces alone can provide adequate physical security.

The conclusion of the plutonium conversion part of this report was that its safeguards system would be able to ensure that the risk from the design-basis safeguards threat is no greater than at similar facilities. As explained above, the bases for this conclusion were (1) that the proposed safeguards system for the conversion facility includes all essential elements and, (2) that DOE's performance goals are technically feasible and similar to the NRC requirements for comparable facilities. Stating that the risk to the conversion facility would be no greater than the risk to currently operating facilities is another way of saying that DOE's proposed safeguards would provide a level of protection comparable to NRC's requirements for its licensees.

12.12.E.4 DOE Safeguards System for Fuel Fabrication Facilities

NRDC-109--Fuel Fabrication Facilities Safeguards: The responses to the comments on DOE's proposed safeguards for plutonium conversion apply here as well and will not be repeated.

12.12.E.6 DOE Safeguards System for Reprocessing

NRDC-110--Reprocessing Safeguards: Some comments previously addressed on conversion apply to reprocessing; because the same responses apply in this case, they are not repeated.

The staff does not agree with the statement that the use of a limit of error based on a percentage of throughput is an invalid basis for an MC&A program. The term "limit of error" has been subject to controversy and has been used somewhat inconsistently. The staff is considering a change in terminology, but feels that the limit-of-error concept is valid. In its proposal under development for an MC&A rulemaking, the staff has continued to rely on the inventory difference and its standard deviation as a useful part of an MC&A system. Also, the limit of error is not "based" on a percentage of throughput in the sense implied by the comment. The limit of error is normally assigned a value that is twice the standard deviation of the accounting measurement system in question. Current NRC regulations stipulate that a licensee's estimated limit of error is acceptable only if it does not exceed a specified percentage of throughput; this does not mean that the limit of error is in any way "based" on a percentage of throughput.

Section E.6.2 references DOE's statement that the yearly limit of error of the physical inventory accounting measurement system for the DRP would be about 0.7% of throughput. Although the staff did not reference the statement in the FES, DOE stated in the ER (p. 5.7-57) that the 1-month limit of error would be 0.8% and the 6-month limit of error 0.75% of throughput. For the purposes of this review, the staff has concluded that, whichever balance period is used,

such limits of error would provide acceptable MC&A when combined with the many other safeguards measures proposed by DOE.

The staff believes that a measurement system limit of error of 0.7% of throughput is technically realistic for a reprocessing plant, especially in the context of a facility operating a few years in the future. The staff does not know what the throughput of the Savannah River plant was in the first half of FY81 or if the inventory difference quoted in the comment is correct, but, in any case, the staff's opinion would not be altered by the experience of a single facility during a single balance period. The measured parameters used to perform material balances vary in a random manner and inventory differences larger than the limit of error are expected from time to time.

In Section E.6.4, the staff pointed out that DOE's proposals for rapid material accounting in the reprocessing plant might require measurement capabilities that have not yet been demonstrated on an operational basis. However, the staff concluded that substantial progress is being made in developing new technologies for application to reprocessing plants, and that in the time frame of the DRP it should be possible for DOE to implement the sort of advanced MC&A system DOE has proposed. In particular, the staff is thinking of the numerous MC&A experiments conducted during the last 3 or 4 years at the Barnwell Nuclear Fuel Plant. One of these experiments was referenced by DOE on p. 5.7-58 of the ER.

NRDC-111--Assessment of Reprocessing Safeguards: The previous response, NRDC-110, addresses the issue of how the staff reached its conclusions. The availability of plutonium for the initial loading is outside the scope of this proceeding and will not be addressed.

WE-14--Plutonium Diversion, Nuclear Proliferation: Mr. Eddleman contends that (1) plutonium can be diverted from the CRBR, (2) the CRBR will contribute to nuclear proliferation, and (3) the only reason to construct CRBR is to produce plutonium for weapons.

As noted in CSE-1, the staff has reviewed DOE's proposals for safeguarding the plutonium at the CRBR and its supporting fuel cycle and transportation activities, and has concluded that the probability of a successful diversion of plutonium would be acceptably low.

It is beyond the scope of this environmental review to consider the overall nonproliferation policies of the U.S. Further, the staff does not believe that the CRBR itself would contribute to the proliferation of nuclear weapons. The reactor and all of its supporting facilities will be located in the U.S. and, contrary to the statement in the comment, the staff does not know of any program that will make the "plans, etc." freely available to foreign nations.

In addition the staff finds no basis to substantiate Mr. Eddleman's claims that construction of an LMFBF fuel cycle would be an economical way to produce plutonium for a nuclear weapons program, or that weapons production is the only reason to construct an LMFBF. The final EIS on the LMFBF program (DOE/EIS-0085-FS) advances many reasons related to long-term power production for developing an LMFBF fuel cycle; none of the reasons involve weapons production.

12.12.E.8 Transportation Safeguards

MS-3--Secure Transport: Ms. Sinclair states that the safe secure transport (SST) is "not a feasible concept since so many methods of derailing a train or blowing up a truck are possible that would disperse plutonium to the countryside." The SST is a specially designed truck that has been in use by DOE for transport of military materials, and the staff believes that it would provide an acceptable method of transporting CRBR plutonium materials by road. A few of the safeguards features of the SST are discussed in Section E.8. Additional information can be obtained from the following reports:

- (1) "Design Concepts Study of a Special Nuclear Material Cargo Vehicle," SLA-730930, R. E. Reed, November 1973.
- (2) "Technology for Commercial Radioactive Waste Management," Vol. 4, DOE/ET-0028, May 1979.
- (3) "Alternatives for Managing Wastes from Reactor Post-Fission Operations in the LWR Fuel Cycle," Vol. 3, NUREG/CR-0028, R. L. Rinne, July 1978.

NRDC-112--DOE Safeguards: In the transportation section, as in the others, the staff did not attempt to compare DOE's proposals to the NRC's requirements for licensees. Of the facilities or activities discussed in Appendix E, only the CRBRP will be licensed. The staff did not conclude that DOE's transportation proposals would meet the NRC's regulations, only that they meet the criteria of Section E.1.

SA-1--Transportation Safety: The staff finds no basis in fact for the assertion that rail is not a safe means of transportation and that the railway accident rate is rising. Statistics from the Federal Railroad Administration show that the accident rate is actually declining.

With regard to the temperature that a cask may be exposed to in a serious accident, the regulatory design test is a 1/2-hour exposure to a thermal radiation source of 1475°F, having an emissivity of 0.9. The effect of this test is equivalent to a seemingly hotter 1/2-hour hydrocarbon fuel fire from gasoline, kerosene, etc. In an actual fire, the temperature would not be uniformly at 1850°F; it would exhibit a temperature distribution with a peak temperature averaging around 1850°F. The local temperatures depend on ventilation (i.e., available oxygen) and the presence of massive cooling surfaces (i.e., heat sinks). Ventilation would tend to increase flame temperatures; massive cooling surfaces would absorb heat and tend to decrease flame temperatures. A large fire surrounding a cask would likely have a peak temperature some distance away from the massive cask. The fire would have to be large to engulf the cask, making ventilation poor. It has been shown that packages respond to the regulatory requirements of withstanding a 1475°F fire about the same as they would to actual hydrocarbon fires (Bader).

With regard to fire duration, the probability of exceeding the 1/2-hour fire in an accident has been studied and found to be small (WASH-1238). Cask heat limitations following an accident sequence are primarily based on internal heating caused by loss of the neutron shield water (increased thermal resistance resulting from the air gap created). Casks are massive and are generally insensitive to a fire's ability to heat the cask externally.

It is not necessary to model all accidents in the regulatory package standards as long as the standards result in packages that will survive most transportation accidents. Accident crush forces are a good example, since there is no specific regulatory accident crush test. An NRC-sponsored study of accidental crush forces, NUREG-1588, concludes that for packages such as spent fuel casks the regulatory impact test ensures a level of protection against accidental crush forces at least as high as the level of protection provided against accident impact and puncture forces. Adequate crush resistance is therefore provided without the need for a specific crush test.

The NRC requires applicants to demonstrate that proposed cask designs meets NRC safety standards. This demonstration may be by means of full-scale testing, scale model testing, engineering analysis, or a combination of these methods.

The use of engineering analysis techniques, including computer modeling, is a well established and verified engineering practice. A number of computer programs are available and have been used by engineers to accurately model a variety of different systems and to successfully predict their performance under specified conditions. Simplifying assumptions of a conservative or bounding nature are routinely used to reduce the amount of analysis required to obtain necessary results.

Although casks in current use have not been subjected to full-scale physical tests, a number of obsolete casks have been tested by DOE. In one test, a truck carrying a cask was deliberately placed in the path of a speeding locomotive. The 120-ton locomotive struck the cask at a speed of 80 miles per hour. In another test, a cask aboard a truck moving at about 80 miles per hour was deliberately crashed into an immovable concrete structure. Subsequent examination in both tests indicated that no radioactive material would have been released if the casks had been loaded with spent fuel. In addition, the observed test results were in good agreement with the engineering evaluations made before the tests were conducted.

Normally, valves on cask shipments involving liquids provide protection against overpressurization during accident conditions of transport. Only one package design assumed operation of the valve following the accident, and even if the valve failed, the release of radioactive material would not exceed International Atomic Energy Agency limits.

Quality assurance procedures have detected deficiencies in some casks and have led to remedial actions as noted below.

In 1979, as a result of a "quality assurance" review, Nuclear Assurance Corporation informed the NRC that one of its casks deviated from the design approved by the NRC. The deviations consisted of a small region of reduced lead shielding and the inner shell being bowed along its length so that it was outside the straightness limit specified on the drawings. Copper plates had been welded to the outer shell of the cask to provide additional shielding to compensate for the region of reduced lead shielding.

Upon receiving this information, the NRC ordered all casks of this design withdrawn from service until it could be determined that the casks were fabricated properly and met NRC requirements. Subsequently, the inner shells

of four other Model No. NFS-4 casks were found to be outside the straightness limit specified on the drawings.

The casks whose shells did conform to the drawing specifications were returned to service with restrictions placed on their contents and operating conditions. Those casks whose shells do not conform to the drawings remain out of service pending a demonstration of adequacy by the licensee.

Based on inspections performed by the staff, there are no indications that structural materials other than those approved by the NRC were used to fabricate the casks. The copper plates are a shielding material and are not used for a structural purpose. Also, the cask welds were inspected following accepted procedures and there are no indications that the welds are faulty.

The analysis referred to by the commentor is believed to be that presented in a Council of Economic Priorities (CEP) newsletter dated January 1982, for which Mr. Resnikoff was a contributor. The source term used in the CEP evaluation is unrealistically large for a transportation accident because it assumes a 10% release of cesium. A February 1980 study by Oak Ridge National Laboratory, NUREG/CR-0722, simulating a cask loss-of-coolant accident, found a fractional release of 0.3% for cesium from the fuel elements, not from the cask. The amount released from the cask is expected to be much less because of the plate-out of cesium on the interior of the cask. Therefore, NRC staff believes a 10% release fraction for cesium is excessively high by several orders of magnitude. Using a reasonable source term, the NRC staff estimates that the release of cesium would result in no early fatalities and only tens of latent cancer fatalities.

The basis for the CEP assumption that 0.5 square mile would be off limits for over a hundred years is not given. Even if a release of radioactivity were to occur, the staff sees no reason why decontamination procedures for the area could not be performed.

SRIC-6--Theft and Sabotage: Safeguards issues related to the CRBRP and its fuel cycle are discussed in Section 7.3 and Appendix E. The staff recognizes that theft and sabotage risks must be considered in this environmental impact review and believes that Section 7.3 and Appendix E adequately cover those risks. See response NRDC-103 for further discussions of the scope of the staff's safeguards review.

12.12.J Addendum to Section 7.1: Plant Accidents Involving Radioactive Materials

12.12.J.1 Design-Basis Accidents

UCS-2--Probability Estimates, Containment Isolation Failure Rates: It is correct that the probability and frequency estimates in Appendix J are not based on detailed analysis of the final design or on operating procedures. Since the NRC's Statement of Interim Policy regarding treatment of accidents in NEPA reviews (Federal Register, Vol. 45, No. 116, June 13, 1980) was issued, it has been the staff's practice to include in the FES only preliminary estimates of accident frequencies based on similarity of the proposed design to other plants, rather than on final analyses of design or procedures.

In its Statement of Interim Policy, the Commission recognized that there are "many uncertainties in the application of risk assessment methods." In the case of CRBR, the use of similarity arguments based on LWR system unreliabilities has been employed only where justified by the fact that the CRBR system design and functions will not be significantly affected by the special nature of a fast sodium-cooled reactor. Specifically, in the case of the containment isolation function, there have been a number of analyses of LWR containment isolation systems that indicate an unreliability range of 10^{-4} to 10^{-2} per demand. For the Appendix J analysis, the upper end of this range was chosen. The staff believes this to be achievable for CRBR, a new plant.

The unavailability averages given in Weinstein's article cited by the commentor refer to a spectrum of LWRs of various ages. An estimate of 15% unavailability of containment is made in the article by Weinstein. These data are primarily from containment leakage tests over the past years; most of the data contributing to the 15% were the result of small leaks with leakage rates a few times the allowable rate. This is especially so in the more recent data, reflecting the continuing efforts made to improve the reliability of containment. The data are not inconsistent with the staff's estimate of achievable containment unavailability at CRBRP. See also the response to NRDC-119 in Section 12.12.J.2.

WE-1--Accident Frequency Estimates: See the following responses to similar comments: NRDC 114c, 114d, 114e, and UCS-2. To summarize these responses as they refer to comment WE-1, the staff has typically employed preliminary estimates of accident frequencies based on similarity arguments, rather than accident frequencies based on final designs. For CRBR this has been done only where justified.

WE-2--Accommodating Energetic CDAs: The comment refers to "some uncertain corrective action" that may be taken to accommodate high CDA energetics. Although the details of the corrective measures may be uncertain, the feasibility of achieving these corrections is not. The staff is confident that, should it be deemed necessary, it is feasible to provide additional or modified design features to ensure that spray fires or missiles will not cause early containment failure.

WE-3--Possibility of Containment Isolation Failure: See the following responses to similar comments: UCS-2, NRDC-115, and NRDC-119.

WE-4--Release of Primary Coolant: The effects of release of the primary coolant system sodium inventory (one million pounds) are taken into account in the Appendix J analysis. Specifically in primary coolant system failure Categories II, III, and IV, it is assumed that failure of the reactor vessel and its guard vessel by meltthrough leads to deposition of sodium and core debris into the reactor cavity. Also, sodium vapor is assumed to eventually reach the containment and cause a sodium fire by reaction of sodium with the available oxygen. Heat generated by this reaction could be comparable to the decay heat generation. Because these effects could lead to pressures beyond the capability of the design of the containment shell, pressure relief has been included in the design by a special venting and filtration system. It is the possible failure of these mitigating systems that could lead to the overpressure containment failure mode considered in CDA Class 2 in Table J.2 of Appendix J. The consequence model also incorporates in the dispersion of the plume the effects of the internal energy of the materials released from the containment.

12.12.J.2 Evaluation of Class 9 Accidents

CEC-3--Reliance on WASH-1400 Accident Probabilities: The staff has not relied solely on WASH-1400 accident probabilities for the evaluation of the consequences of CRBRP accidents. Since WASH-1400, there have been numerous studies from a variety of organizations both in the U.S. and in foreign countries that analyze the frequency of core degradation and also the contribution of specific systems, functions, and sequences to core degradation. This body of information was used where appropriate to estimate the frequency of CRBRP accident initiators and core degradation events.

As discussed in Section J.1.2(6) of Appendix J, the findings of the Lewis Report on the limitations of WASH-1400 have been taken into consideration in preparing Appendix J.

The new report, "Precursors to Potential Severe Core Damage Accidents: 1969-1979, a Status Report" (NUREG/CR-2497), describes a process by which Licensee Event Reports (LERs) of operational events that have occurred at light-water power reactors between 1969 and 1979 were reviewed to identify and categorize precursors to potentially significant accident sequences. The report includes event trees to estimate the frequency of core damage that could possibly occur, considering additional systems failures after precursor events. The event trees in this study, contrary to WASH-1400, are generic and use generic data that cannot be associated with actual events at the plants at which the precursors occurred. Whereas WASH-1400 assesses the frequency of core degradation events for two specific reactors of relatively recent design for the period when WASH-1400 was published, NUREG/CR-2497 attempts to evaluate the frequency of these events for all operating nuclear power plants. As is indicated in the report foreword:

This report, covering 1969-1979 LERs, is being released as a progress report with the expectation that some conclusions may need to be changed as the report undergoes continuing peer review and public comment.

Near the end of the foreword, the statement is made: "The full meaning and limitations of the severe core damage calculations made in this report are not clear." Thus while numerical estimates of core degradation are derived in NUREG/CR-2497, the basis and assumptions used are significantly different than those used in WASH-1400.

The staff has reviewed NUREG/CR-2497 to determine its applicability to CRBR and to determine whether the accident frequency estimates of Appendix J should be changed because of the new information. Some of the important specific precursors identified in the report do not apply to CRBR. The three major contributors to the generic core melt frequency of 1.7×10^{-3} /year come from the TMI-2 event, the Browns Ferry fire, and the Rancho Seco nonnuclear instrumentation failure and consequential steam generator dryout. In the first two of these cases, generic remedial measures have been taken to ensure that such events do not recur at LWRs, and in the third case the cause of the precursor event was specific to the vendor design.

After the Browns Ferry fire, considerable attention was devoted to development of new requirements to prevent loss of safety function from fires. These

requirements are contained in Appendix R to 10 CFR 50 and in the Standard Review Plan (NUREG-0800) and are applied to each reactor during licensing reviews, including CRBR. Similarly, after the TMI-2 accident a number of new requirements related to improvements in auxiliary feedwater system design and human factors were incorporated into the NRC review process. These new requirements will be imposed on CRBR. The Rancho Seco event was the result of an adverse inter-dependency between the nonsafety control system and the auxiliary feedwater system. CRBR will have a modern safety-grade auxiliary feedwater system with automatic initiation and imposed independence from nonsafety instrumentation and control systems. Furthermore, as defense-in-depth, CRBR will have a backup direct heat removal system (DHRS) and post-accident monitoring instrument capabilities comparable to Regulatory Guide 1.97, which will allow the operator to diagnose problems. CRBRP will also include additional features such as two independent, diverse and functionally redundant fast-acting reactor shutdown systems, and a heat transport system of very high integrity to help ensure that the frequency of core degradation events is very low. For these reasons, the staff concludes that the three major contributors to the NUREG/CR-2497 generic core melt frequency do not apply to CRBR. Exclusion of these events, according to NUREG/CR-2497, leads to a residual core-melt frequency of 7.7×10^{-4} based on other precursors treated generically. As discussed above, there are reservations about the use of such generic estimates. However, their residual core melt frequency is not inconsistent with the estimates of Appendix J, recognizing that there are uncertainties in both analyses. If consideration is given to the extra redundancy and independence of the CRBR shutdown and heat removal systems, it is reasonable to attribute a higher potential reliability to CRBR than to the generic class of reactors considered in NUREG/CR-2497.

In summary the staff concludes that the accident frequency estimates of Appendix J are reasonable.

CWE-3--Accident Consequence-Probability of Occurrence: The quoted interim policy statement requires that the consequences of accidents be discussed and evaluated in light of their probability of occurrence. This is accomplished in Appendix J to the FES. There is no requirement for a specific format in which this information is to be addressed. The staff believes that the format of the presentation of Appendix J is suitable to and properly characterizes the nature and scope of the supporting calculations. Notwithstanding this conclusion, CCDFs have been included in the FES supplement.

CWE-4--Uncertainties in Accident Analyses: The risk calculations forming the basis for CCDF curves are performed as estimates of probabilities and consequences. The CCDF curves, therefore, do not reflect the uncertainties associated with the calculation. The staff's judgment regarding uncertainties involved in current estimates of risk, based on the WASH-1400 methodology, is discussed in Section J.1.2(6) of Appendix J and in the staff response to comments WE-5 and WE-6. See also the response to CWE-3 and UCS-3 elsewhere in this section.

CWE-5--CRAC Computer Run: See the response to CWE-3 above.

DOE-Z--Primary System Failure Category Grouping: Table J.2 and the text have been made consistent.

DOE-AA--Other Economic Risk: In line 9 of paragraph J.1.2(5) "more" has been changed to "less."

NRDC-114a--Safety Goal Quantification: The comment states that the staff should quantify the term "made very improbable." In its licensing review of CRBRP, the staff is not relying on specific numerical probability thresholds. It is the staff's judgment that severe accident initiation is made sufficiently improbable by imposing such deterministic criteria as quality assurance, compliance with regulatory standards, and redundancy, independence, and diversity of safety systems. General discussions of these deterministic criteria were included in the Site Suitability Report (NUREG-0786).

NRDC-114b--Extent of Core Disruption: The term "core disruption" is considered to involve a change in fuel assembly geometry from its design configuration of such a degree that undercooling or reactivity increase might occur. The staff views the extent of core disruption in different ways for different purposes. In reviewing the adequacy of design measures to prevent initial fuel failure from propagating, the staff requires that such failures not lead to additional failures beyond a limited region, such as a few fuel pins. However, in evaluating the risks from CDAs, the staff considers more widespread disruption. The risk estimates in Appendix J were based on the assumption that the whole core, including the blanket assemblies, was involved in the accident.

NRDC-114c--Frequency of LOHS: As described in Appendix J the frequency of loss of heat sink (LOHS) is based in part on the redundancy and diversity of the CRBR decay heat removal systems and in part on the reliability of PWRs, which have redundancy and diversity in their auxiliary feedwater systems (AFWSs) similar to the CRBR steam generator auxiliary heat removal system (SGAHS). Evaluations of PWR AFWS reliabilities, including that in WASH-1400 and more recent studies, suggest that failure frequencies in the range of 10^{-5} to 10^{-4} per demand may be achieved. Implementation of lessons learned from TMI 2 will also serve to increase reliability. The general trend of these studies rather than a specific case is the basis for the conclusion that the CRBR SGAHS can achieve similar reliability. Because CRBR also has another decay heat removal system to back up the SGAHS, the staff believes the LOHS failure frequency will be below 10^{-4} per year. The formal reliability program at CRBR adds further assurance that this will be the case.

NRDC-114d--Similarities to LWRs: Some systems in the proposed CRBRP design are quite similar to those in LWRs; examples are the fast-acting reactor shutdown systems and the auxiliary feedwater systems. In other cases, important subsystems are similar; for example, the electronic controls. Such similarities provide grounds for the staff's judgment that it is feasible to achieve comparable reliability in CRBRP systems. As discussed in the response to NRDC-114c above, a number of reliability studies have been considered in addition to WASH-1400. However, no one of these has been relied on in detail.

NRDC-114e--Common Mode and Multiple Failures: Every severe accident considered in Appendix J involves multiple failures; an unprotected loss of flow (ULOF) event, for example, involves a number of failures in just the nonresponse of the reactor protection system.

In each case where a function, system, or sequence failure frequency is estimated, consideration is given to potential common mode and other dependent failures. The frequencies assigned include these factors. In each instance, relative assessments with LWRs were made of the operating environment as well

as the requirements from supporting systems, operators, and maintenance personnel. These assessments also include specific requirements for operation such as the time available for the specific function or system to begin operation and the length of time operation is required. For example, the reactor protection, heat removal, and containment isolation systems have comparable operator and maintenance personnel interfaces as well as support systems requirements. Thus the judgment that unavailability contributions from human error and other support systems (considering that it is feasible to have operators and support systems that perform in CRBRP comparable to LWRs) is similar to LWRs can be made. In some instances, LWR experience must be augmented to provide needed frequency estimates. These estimates were then made conservatively, recognizing uncertainties associated with common mode and dependencies.

In the case of the reactor protection system, for example, each fast-acting shutdown system (primary and secondary) is comparable to the single fast-acting shutdown system in LWRs. There are no LWRs with two fast-acting shutdown systems. If complete credit had been given for the two systems being independent in CRBRP, shutdown unavailability would have been in the range of 10^{-7} per demand. Complete credit was not given; in fact, a considerable allowance was made for common mode failures between the two shutdown systems because the estimate provided in the supplement is about two orders of magnitude greater than the combined independent unavailability and only about one order of magnitude less than the unavailability of a comparable modern LWR shutdown system.

In other instances (for example, loss of heat sink accidents), more time may be available for specific scenarios to start up the system at CRBRP than is the case for some LWRs. Typically, however, no additional credit was given during the quantification of CRBRP frequencies for such perceived factors. Instead, the approach used was to ensure equal or better comparability with appropriate LWR situations and not reduce CRBRP frequency estimates in the supplement because of perceived advantageous factors.

NRDC-115--Reliability Program: The applicants' proposed reliability program (Appendix C of the PSAR) is currently under review to determine what changes, if any, will be needed in the program. Consequently, the staff has not relied on the applicants' proposed program or any documents describing it. However, the staff believes that an effective reliability program for CRBR can be developed. Some important general elements of such a program are: (1) formal documentation of reliability procedures including those related to operation, testing, surveillance, and maintenance; (2) utilization of appropriate reliability techniques such as fault trees, event trees, failure modes and effects analyses, and probabilistic risk assessment; (3) systematic elimination of common cause failure modes; and (4) performance of tests on components and systems for preservice and inservice inspection to establish a quantitative data base. The staff sees no reason why these criteria cannot be achieved.

NRDC-116a--Reactor Shutdown System Failure Frequency: In NUREG-0460, "Anticipated Transients Without Scram for Light Water Reactors," Vol. I, Section 4.3, an estimate of the frequency of ATWS for typical LWRs was given as 2×10^{-4} per year. Estimates in this same range were subsequently quoted by the Commission in its statement regarding ATWS rulemaking. The currently proposed design of the CRBR shutdown system includes two independent and diverse systems, each of which is comparable to an LWR shutdown system. Furthermore, CRBR is a modern plant, as contrasted to the general class of plants used to arrive at the

generic ATWS frequency estimates of NUREG-0460 or referred to in the ATWS rule-making statement.

For the above reasons, the staff concludes that it is reasonable to attribute an ATWS frequency no greater than 10^{-5} to CRBR. See also the response to NRDC-114e above.

NRDC-116b--Fuel Failure Detection: Prevention of failure propagation is primarily achieved by passive design measures (i.e., mechanical strength and ruggedness), supplemented by a detection system. The details of the systems to prevent propagation of slowly developing faults are not final at this time. The criteria for such systems will be reported in the SER. Based on general knowledge of the feasible design of such systems, the staff is confident that it is possible to install a sufficiently reliable system for detection of fuel faults at CRBR. It is anticipated that a relatively simple detection system design meeting NRC regulatory guidelines for accident monitoring instrumentation will suffice. The most likely design concept is that of detection of delayed neutrons from fuel leached into the coolant, as was used at Fermi 1, SEFOR, and FFTF.

NRDC-117--Combined Probability of Core Disruption Initiators: The initiator class frequencies represent, in each case, a judgment that each frequency is no greater than 1×10^{-4} per reactor year and is expected to be appreciably smaller. Further, the scoping nature of this analysis is consistent with order of magnitude estimates of individual contributors to core disruption. In each case, frequencies are rounded off to the next largest order of magnitude to obtain bounding estimates. To do otherwise would indicate a misleading level of precision in these preliminary frequency estimates. Thus it is from the viewpoint that each class frequency is expected to be appreciably smaller than 1×10^{-4} per reactor year that the judgment is made that the sum of these frequencies is no greater than 1×10^{-4} per year.

NRDC-118--Primary System Failure Probabilities: The staff's estimate that the conditional probability of primary system failure Category IV is 0.1 was based on two points. First, for simplicity, a single general CDA initiation frequency of approximately 10^{-4} /year, which included the combined frequencies of various specific CDA initiators, was used. However, the specific CDA initiators do not have equal potential for resulting in an energetic CDA. The fraction 0.1 was therefore, in part, employed to compensate for this simplification. Second, the staff's general knowledge of and experience with the extensive research on the phenomena that may occur in a core disruptive accident has led to the judgment that energetics large enough to cause a Category IV type failure are relatively unlikely to occur even if a CDA is initiated. Factors which have been a consideration in this judgment are (1) incoherent fuel failures and material rearrangement are more likely than the coherent behavior associated with high energetics, (2) small criticalities which disperse fissionable material without energetics are more likely than large energetic criticalities, (3) the heterogeneous core design slows down power escalations due to voiding and minimizes the potential for rapid reactivity insertion due to fuel motion, and (4) the upper internals structures have an effect in mitigating CDA-generated forces.

NRDC-119--Probability of Containment Failure: During normal operation of the CRBRP, the containment will be closed. Inlet and exhaust ventilation ducts, however, will be open to circulate outside air through the containment. It is the purpose, therefore, of the containment isolation system to automatically

shut the appropriate isolation valves to isolate the containment during specific abnormal conditions. The likelihood of a failure in the system required to automatically isolate the containment ventilation system has been considered in the staff analysis.

The basis for assigning a frequency of 10^{-2} per demand or less for the containment isolation system is the feasibility of the CRBRP design or variations thereof achieving this level of availability or better, considering environmental factors, common mode failures, and an appropriate level of reliability of required supporting systems and functions. Typical LWR containment isolation systems, considering the above factors, have unavailabilities in the range of 10^{-4} to 10^{-2} /demand. Because the proposed CRBRP design is comparable to recent and more reliable LWR systems considering its inherent simplicity, redundancy and independence, the system's unavailability will likely be well below 10^{-2} /demand.

NRDC-120--Time to Overpressurization Failure: This refers to the part of the CDA scenario where the core debris and sodium have fallen into the reactor cavity and penetrated the cavity liner. Heat balance estimates indicate that boiling begins at about 9 hours. Pressure and hydrogen would increase in the containment building at rates dependent on the rate of sodium boiloff and sodium-concrete reaction. The applicants' analyses indicate that venting, purging, and cooling should begin at about 36 hours. Based on the staff's knowledge of the possibility of sodium-concrete reaction rates greater than assumed by the applicants, the staff has selected 24 hours as a reasonable estimate of the time at which venting, purging, and cooling would be necessary. For this CDA scenario, it was assumed that one of the active systems would fail to function, causing containment failure at 24 hours.

NRDC-121--Common Cause in Containment Failure: See response to NRDC-114e.

NRDC-122a--Estimates of Percentage of Core Inventory Released: The values of the percent of core inventory released to the environment for each of the four CDA classes presented in Table J.2 are based on contributions from three sources: vessel head releases, boiling releases, and dry cavity releases. The head releases to the reactor containment building (RCB) are specified in Table J.3. The head releases in primary system failure Category III are conservatively used for CDA Class 3 of Table J.2. CDA Classes 1, 2, and 4 conservatively use primary system failure Category IV head releases.

Pool releases to the RCB depend on the relative volatility of the specific isotopes compared to that of sodium. All I and Cs-Rb remaining in the pool is assumed to be released to the RCB. About 50% of the remaining Te-Sb and Ba-Sr isotope groups are assumed to be released and none of the solid fission product groups (Ru and La) are assumed to be released to RCB during the pool boiloff process.

After cavity dryout, about 12% of the remaining Te-Sb and Ba-Sr isotope groups (about 5% of their total inventory) and about 5% of the remaining Ru and La groups (nearly 5% of their inventory) are estimated to be released to the RCB.

Once the input of sodium and fission products into the RCB is determined, the releases to the environment can be estimated. For each CDA class and RCB source term (head, pool, dry cavity releases) the containment leakage mode

(filtered or unfiltered) and rate, as well as the approximate sodium aerosol concentration in the RCB, are estimated.

Thus the ratio of leakage rate to leakage plus fallout rates (as discussed on page J-10 of the Draft Supplement) is estimated for each CDA class and RCB source term. This ratio, when multiplied by the fraction of each isotope in the RCB, results in an estimate of the fraction of each isotope released out of the RCB. If filtering is operative, the filtering inefficiency (1 minus filter efficiency) is also multiplied with the release fraction to obtain the environmental release fraction. Once the release fractions to the environment are calculated, for each isotope group of each RCB source term of each CDA class, they are combined to form a total release fraction for each CDA class. The releases represented by a set of isotope group release fractions are then used as input into the consequence model.

The discussion in Appendix VII of the Reactor Safety Study (WASH-1400) provides a general background on the release fraction selection process used for Appendix J and discussed above.

NRDC-122b--Filter Efficiencies: The staff has estimated filter efficiencies in filtered venting at 97% for iodines and 99% for particulates. For the final CRBRP design, filters will be required that can withstand the environmental conditions and achieve such efficiencies. The applicants have shown the staff results of scaled tests based on a system like the proposed system; the results provide the required efficiencies.

NRDC-123--Atmospheric Pathway Consequences: As stated in the supplement, the atmospheric pathways consequence analysis of the Class 9 accidents was performed using the RSS approach described in great detail (including all the assumptions made) in Appendix VI of WASH-1400. An overview of this RSS consequence model is presented in NUREG-0340. The calculational methodology is coded in the CRAC computer code. The Class 9 accident analysis performed by the staff using the CRAC code is in the form of computer printouts in the staff files, and is available for examination and copying.

NRDC-124--Spectrum of Consequences: The staff agrees with this comment and has included the probability distribution of a spectrum of accidents in the supplement. The basis of the calculations is discussed in the response to NRDC-123.

NRDC-125--Common Cause: See response to NRDC-114e.

NRDC-126--Extremely Energetic CDA Probability: The basis for the conditional frequency of 0.1 for primary system failure Category IV is given in the response to NRDC-118 above. The statement regarding the quantification of the frequency of the extreme energetic CDA, on page J-18 of the Draft Supplement, was included in recognition of the remote possibility that the highly coherent behavior among other factors (see the response to NRDC-118) needed for high energetics could occur. The staff is not currently aware of any way this could happen through a natural course of events, but it is possible to speculate or hypothesize such behavior. Because of the speculative and hypothetical conditions needed for high energetics, it is not meaningful at this time to quantify the conditional frequency of such conditions. However, the staff is confident that the conditional frequency is much smaller than 0.1. A further discussion of uncertainty bounds is provided in the response to comment WE-6 below.

OCRE-3 Energy Release in Accidents: Contrary to the assertion in the comment, the risk analysis in Appendix J indicates that the risks from CRBR are not greater than the risks from LWRs. However, the remote possibility that CRBR could suffer a criticality accident (which Dr. Webb discusses) has been considered in Chapter 7 and Appendix J. Such a recriticality would not result in an energy release over such short duration that it would be characterized as an explosion.

As discussed in Section J.1.2(6) of Appendix J and in the response to NRDC-118 and -126, the staff considers it only remotely possible that the energy release could be large enough to fail a containment like that proposed for CRBR. The environmental consequences for that case are addressed in Appendix J, and evacuation could well be an appropriate response to such a release and is considered in the consequence model.

With regard to the accidents at EBR I and Fermi 1, see response to comment WAL-1.

UCS-1--Comparison with LWR Consequences: The doses reported in the Table J.1 of the supplement are 2-hour release doses at the exclusion area boundaries. The supplement has been accordingly corrected.

The CRBRP doses in the Table J.1 are from FES Table 7.2 and, as stated in the Draft Supplement, take into account the very different nature of the CRBRP from that of LWRs. The staff has compared these CRBRP results with those of the LWR doses calculated by methods appropriate for LWRs. The staff agrees with the commentor that there is approximately a factor of 3 difference in the power levels of the CRBRP and the LWRs. The supplement has been revised to indicate the power levels of the reactors compared in Table J.1. Even when the factor of 3 difference is considered, the staff conclusion "based on the comparison of the calculated realistic CRBRP dose consequences with those of the LWRs, the doses reported in Table 7.2 of the FES appear to be reasonable" does not change.

The staff used a postulated source term in its analysis of the site suitability design-basis accident by assuming that, even though the protection is provided against the melting of the fuel, fuel melting occurs and the fission products are released from the core in proportions similar to those postulated for the LWR design-basis LOCA. See NUREG-0786 (the Site Suitability Report), Section III.D, page III-8, for further discussion of this point. The staff did not use the inventories reported in the WASH-1400 in its analysis of the CRBRP accidents. The source term for the CRBRP is postulated in terms of fractions of the CRBRP core inventories; it, therefore, does account for the curies content of the radionuclides present in the CRBRP core.

The staff agrees with the commentor that the societal or individual risks of the design-basis accidents are not significant. The design-basis accident doses are, however, included in the supplement to ensure completeness of the examination of the accident risks for a broad range of reactor accidents.

The staff's comparison of the site boundary doses due to design-basis accidents is an appropriate one, because the risk to the public is presumed to commence at the site boundaries of the plants.

The staff does not agree with the commentor that comparison of the design-basis accident doses is "a waste of time and of precious little use." The comparison

is provided in support of the doses presented in the FES Table 7.2, and does suggest that those doses (Table 7.2) are not higher than those of LWRs.

UCS-3--Risk Comparisons Between CRBR and LWRs: The staff has considered the uncertainties in probability estimates. The staff's discussion of uncertainties is presented in Section J.1.2(6) of Appendix J. The staff, in response to comment WE-6 below, provides a judgment, based upon the considerations given to the CRBRP accidents in Appendix J, that the uncertainty bounds in the risk evaluations could be over a factor of 10, and may be as large as 100, but are not likely to be greater than 100. In the Midland FES, the staff discussed the uncertainty bounds associated with the Midland risk evaluations and make a similar assessment of uncertainties. The staff believes that the uncertainty bounds have to be considered in evaluating both cases.

The staff is adding the CRBRP accident consequence probability distribution in Appendix J. The staff agrees that such additional information will be meaningful. Although there is a factor of 2 difference in the CRBRP and Midland power levels, the estimated average CRBRP risks compared in Table J.5 are a factor of 2 to 20 lower than those for Midland. These differences are quoted here merely to respond to the comment, and are not free from the uncertainties discussed above.

The Draft Supplement included the environmental and public health impacts of land contamination due to higher inventories of the long-lived radionuclides such as plutonium-239. The staff included higher inventories of such nuclides, expected in the CRBRP core, in its consequence analysis performed by the CRAC code. The staff agrees with the comment that the probability distribution of the consequences should be included in Appendix J, and this change to the supplement has been made. In the response to NRDC-122a, the staff has provided a more detailed explanation of the phenomenology of the progression of the postulated accident sequences and the behavior of the fission products, which is the basis of the radionuclides release categories and the releases established in Table J.2.

UCS-4--CRBRP Consequence Analysis: Although the CRAC 2 weather sampling method reduces the variability of the results attributed to sampling, the International Benchmark Exercise that compared several consequence calculation codes found that the final results of the Complimentary Cumulative Distribution Functions (CCDFs) do not show significant differences between the CRAC and CRAC 2 codes. The staff intends to use the CRAC 2 code for its future reviews of probabilistic risk assessments, after the appropriate checks and verifications have been completed.

The staff has included the CRBRP consequences at various probability levels in the supplement. As stated in response to other UCS comments, the CRAC analysis for CRBRP specifically accounts for the higher plutonium-239 inventory in the CRBR core and accounts for the resultant ground contamination as modeled in that code.

WE-5--Basis of Risk Assessment: On page J-19 of the Draft Supplement, the staff gave the Lewis Report findings, which included the assertion: "the methodology (of WASH-1400), which was an important advance over earlier methodologies that have been applied to reactor risks, was sound." The staff agrees with the commentor that a detailed PRA comparable to WASH-1400 has not

yet been completed for the CRBRP. Such a PRA is, however, currently being performed by the applicants and is being reviewed in parallel by the staff. It will, of course, include the failure modes and effects analysis, including the consideration of the different transients associated with the proposed CRBRP steam generators. The staff agrees with the commentor that the task of CRBRP PRA is a very complex one. As stated above, such a task has been undertaken by the applicant and will be reviewed by the staff to ensure that the risk assessments made in the present staff analyses given in Appendix J of the Draft Supplement remain valid within the range of uncertainties expected in PRAs.

WE-6--Uncertainties in PRAs: The state-of-the-art for quantitative evaluation of uncertainties in PRAs is not well developed. It is, however, the judgment of the staff that the analysis will show that the uncertainty bounds could well be over 10, and may even be as large as 100, but are not likely to be larger than 100.

WE-7--Costing Factors: See response to WE-6. The staff has corrected the Supplement to include "replacement of the damaged core" in place of "replacement of the damaged nuclear fuel." The cost of the containment is included in the facility replacement costs. As stated in response to comment WE-6, there are uncertainty bounds in the calculated impacts. Such uncertainty bounds could be a factor of 10 to 100. The staff analysis of land contamination costs did include the consideration of the presence of additional plutonium in the CRBRP core.

WE-8--Cleanup Costs: The staff has provided a realistic analysis of the cleanup costs, including the cost of the offsite decontamination, lowered property values, and the loss of farming (see Appendix VI of WASH-1400 for a discussion of the details of the economic models included in the consequence analysis).

The staff has also considered the impacts of such accidents on ORNL, the Oak Ridge Gaseous Diffusion Plant (ORGDP) and the Y-12 plant, and finds that the potential evacuation of the ORNL, the ORGDP, and Y-12 will not be long term and will not significantly affect the U.S. nuclear industry.

12.12.L Alternative Sites

- Introduction

NRDC-131--Relative Cost To Make the Project Licensable: The staff's judgment that all of the sites considered in Appendix L meet criterion (8) of Section VI.2.b. of NRC's proposed rule for alternative sites is based upon reconnaissance-level information, as intended by the rule. Far more data than usual were available for several of the sites, but the rule does not require that "hard data" be available for site selection. The rationale for this is stated under Supplementary Information Section IV.A.2.2 of the Federal Register Notice (see Appendix K, p. K-4) as follows:

While detailed site-specific baseline studies on the proposed site are required to support the remainder of the NRC's environmental review, these data normally add little to NRC's determinations regarding alternative sites. These

detailed studies principally serve as a basis for decision-making regarding mitigative measures to reduce (on an practicable basis) any residual adverse environmental impacts.

The "significantly different sums of money" mentioned on page L-3 (last sentence of paragraph 2) would be less than 5% of the total capital cost, but no attempt has been made to quantify such figures.

Until an applicant requests cancellation of an existing NRC construction permit, the applicant has the right to initiate or resume construction of a postponed nuclear project. However, when an applicant announces that a project will be cancelled, the staff believes it is reasonable to assume that the project will not be completed. Since the Draft Supplement was issued in July 1982, TVA's Board of Directors has voted to cancel the two units under construction at the Phipps Bend site and two of the four units under construction at the Hartsville site. However, the TVA Board of Directors also declared that those sites are to be returned to TVA's bank of potential sites for development of future commercial power projects. Hence, the availability of already disturbed areas and "completed facilities" at those sites for use by the breeder demonstration plant is unknown to this time. Engineering studies would be necessary to determine whether those areas and facilities could actually be used. In any event, whether the demonstration plant would be on a previously undisturbed portion of each TVA site has little to do with and was not intended to be considered under "Relative Cost To Make the Project Licensable." The text is separated in this supplement to clarify that point.

It is possible that plant costs to meet required safety measures would be less at an alternative site than at the proposed site; engineering studies beyond the scope intended by NRC's proposed alternate sites rule would probably be necessary to make such a determination. In view of the fact that the plant design is nearly complete and about two-thirds of the plant equipment has been delivered or has long been on order, it is likely that the design and equipment would be changed as little as possible if a decision were made to locate the plant at another site. The applicants have estimated the additional costs of a move to any other site as shown in Table A9.4 in Section 9.2.6.2.

The staff does not expect that the costs of safeguards on site would be particularly different for any of the sites. Transportation costs associated with fuel supply and waste disposal requirements for the plant would vary with locations of the facilities involved, but the staff does not believe the cost differences are likely to be great enough to warrant consideration in the selection of nuclear power plant sites.

• Meteorology

NRDC-127a--Description of Criteria: The length of the description of meteorological criteria used in the evaluation of alternative sites is not a relevant measure of the importance attached to these criteria. Meteorological considerations were given equal weight with other siting considerations such as geology, seismology, and hydrology.

The two other "meteorological factors" suggested for consideration--rainfall and fog--are not important for determining the suitability of a nuclear power plant

site. Rainfall is indirectly considered as a hydrologic factor in the context of potential for flooding and water availability. The NRDC statement concerning the adequacy of the onsite meteorological monitoring program and the staff's assessment of routine releases has been previously answered in response to NRDC-40.

- Socioeconomics

NRDC-83 and -129--Socioeconomic Effects of Construction Halt: The staff did not consider the socioeconomic effects of halting construction of the CRBR for two reasons. First, the staff's mandate is to analyze the environmental effects of constructing and operating the CRBR. Second, the analysis of all the possibilities of cessation and resumption would be highly speculative.

As indicated on page 9-12 of the Draft Supplement, a relocation of the CRBR would cause a 3- to 4-year delay in construction. A delay of this magnitude would be accompanied by changes in the labor pool as construction workers migrate to areas of employment. Therefore, the staff did not evaluate the present circumstances at either Hartsville or Hanford.

- Population Density

NRDC-130--Population Estimates: The DES population estimates are based on the 1980 census, and the population projections were confirmed against projections obtained from the U.S. Department of Commerce, Bureau of Economic Analysis (BEA). Because the BEA projections are based on the general level of economic activity expected for a multicounty region, the continuation or cancellation of any single activity, such as a nuclear power plant or a synfuels plant, is not expected to significantly affect these projections.

WE-15, NRDC-135, -136, -137, -138, -139, -150, -155, -162 and -165--Low Population Densities: The staff has revised the discussion of population density in Appendix L of the FES to clarify that population has been used as a threshold factor in judging environmental preferability. The population densities at the Clinch River site as well as at each of the alternative sites are low, and the residual risks from accidents at each of the sites would also be very low despite differences in population. Because these differences are not considered significant, the staff's judgment is that there is no site that is environmentally preferable to another with regard to population density.

12.12.L.1 TVA Sites

NRDC-128 and -143--Information Basis: The staff's analysis is based on reconnaissance-level information as defined in Appendix K. The staff believes that data utilized to evaluate the environmental effects on terrestrial resources and land use in its alternative site analysis are adequate.

NRDC-132--Meteorological Data: All of the TVA service area sites had either onsite meteorological data or data on nearby areas available. All of these sites had comparable joint occurrences of stable atmospheric stability conditions and low windspeeds and each had comparable relative dilution factors (x/Q). These x/Q values have been found to be comparable to those for LWR sites that were deemed licensable. Therefore, the staff believes that the CRBRP and all of the four alternate TVA sites are licensable.

NRDC-142--Aquatic Ecology: The staff has determined that the NPDES permit conditions are adequate to protect aquatic organisms inhabiting the Clinch River in the vicinity of the proposed site. See also the response NRDC-12 addressing the species of endangered freshwater mussels and the response to NRDC-30 addressing Cycleptus elongatus in Watts Bar Reservoir.

12.12.L.1.1 Hartsville

DOE-BB--Flow Rates and Population: The alternative site comparisons of river flow rates and populations served have been revised, based on more complete site information. While the numerical factors have changed, the conclusions remain the same.

DOE-CC--Impacts on Aquatic Biota: The text has been changed to reflect these comments.

DOE-DD--Labor Force Availability: The reference cited in paragraph 2 of Section 1.1.5 of Appendix L has been changed. The staff agrees with the comment that the relative proximity of the labor force at Clinch River compared to Hartsville should weigh in favor of the former. The text has been changed accordingly.

NRDC-133--Aquatic Ecology: The staff reviewed the information available on Polyodon spathula in the Cumberland River and concluded that the possibility existed, based principally on sampling at a nearby fossil plant, that a significant number of juveniles may become impinged on the Hartsville intake screens. Such losses were not projected for sauger at the CRBR intake. The staff concluded, in balance, that with respect to impingement, the CRBR site was preferable to the Hartsville site.

Section 1.1.4.1 of Appendix L addresses construction and considers the advantages of the Hartsville site relative to the Clinch River site.

NRDC-134--State Endangered Species: Quite to the contrary of this comment, the staff had access to detailed site-specific investigations of the Hartsville site that normally would not be available as reconnaissance-level information. The staff's conclusions on alternative sites were therefore based on extensive site-specific data.

NRDC-141--Socioeconomic Effects of Deferral: See response to NRDC-129 above.

12.12.L.1.2 Murphy Hill

NRDC-136--Analysis Basis: The socioeconomic analysis assumed that the coal gasification plant would be built. See word changes on page L-16, paragraph 5 which correct the apparent inconsistency.

NRDC-136--Comparison to the Proposed Site: Compared to the Clinch River, the much larger Tennessee River would provide greater dilution of liquid effluents from the LMFBR demonstration plant and thereby lessen any concern about thermal impacts to aquatic biota. However, the staff does not consider this to be a significant advantage because the impacts of plant effluents on the water quality and biota at the proposed Clinch River site are expected to be negligible (Sections 1.2.2.1 and 1.2.4.1).

The staff has assumed that the coal gasification plant will be constructed at Murphy Hill because TVA has dedicated the site to that purpose and is actively pursuing needed financial arrangements. However, the uncertainties as to its construction and timing caused the staff to make its assessments under various circumstances, as in paragraph 5 on page L-16.

As the comment suggests, if no coal gasification plant is built, construction of the LMFBR demonstration plant on the already cleared Murphy Hill site would result in less terrestrial impact than constructing the plant on the uncleared Clinch River site. This would not be an important advantage, in the staff's opinion, because its assessment of the loss of terrestrial resources as a result of clearing the proposed site is that it would not be environmentally significant (see Section 4.4.1). For the staff's position relative to population density considerations, see the response in Section 12.L.1.4 to comment NRDC-139.

WE-15--Preferability of Murphy Hill: The comment cites Draft Supplement page 11-17, but no mention of the Murphy Hill site appears on page 11-17 of either the 1977 FES or the 1982 Draft Supplement. The staff assumes that the comment refers to page L-17 (Appendix L).

Whether the proposed coal gasification plant will actually be built at Murphy Hill is unknown at this time. The staff understands that the U.S. Synthetic Fuels Corporation is currently considering a request from TVA and/or private interests for financial assistance.

The staff's assessment of Murphy Hill (Appendix L, Section L.1.2) indicates that it probably would be an acceptable site for a nuclear power plant if the coal gasification plant is not constructed there, but the staff did not find it substantially better than the proposed site on Clinch River when all of the environmental parameters are considered. Although population densities around the Murphy Hill site are lower than those in the vicinity of the Clinch River site, this is not a significant advantage because the population densities at both locations are low and the risks associated with plant accidents will also be low (see Section 7.1 and Appendix J). The greater flow in the Tennessee River is also an insignificant advantage because the liquid effluents from CRBRP would be so small that dilution in the Clinch River should be more than adequate.

No unusual difficulty is expected in monitoring radioactive emissions at the Clinch River site (see Section 6.1.2). Although radionuclides were released into White Oak Creek for some time, the present level of radioactivity in Clinch River sediments near the proposed plant site is low (ER Sec. 2.8).

12.12.L.1.3 Phipps Bend

DOE-BB--Flow Rates and Population: The alternative site comparisons of river flow rates and populations served have been revised, based on more complete site information. While the numerical factors have changed, the conclusions remain the same.

NRDC-137--Comparative Assessment: The staff does not believe its aquatic assessment of the Phipps Bend site requires major revision as suggested by the comment. Changes to this section have been made in response to comment DOE-CC.

As discussed previously, the staff performed its assessment of the meteorological aspects of the siting of the CRBRP facility at the Phipps Bend site using onsite meteorological measurements and specific Phipps Bend diffusion analyses and used these data in making the determination that the Phipps Bend and Clinch River sites were comparable and that both sites were licensable from a meteorological point of view.

The 3000-person difference in the size of the labor pool at Phipps Bend results in a less preferable rating for that site compared to the CRBR site. See also the discussion under Introduction to Appendix L relative to socioeconomics.

12.12.L.1.4 Yellow Creek

DOE-BB--Flow Rates and Population: The alternative site comparisons of river flow rates and populations served have been revised, based on more complete site information. While the numerical factors have changed, the conclusions remain the same.

NRDC-138--Comparative Assessment: The staff does not believe that its assessment on aquatic resources for the Yellow Creek site requires reassessment as a result of this comment.

For a discussion of socioeconomic effects, see the response to NRDC-129 above.

As discussed previously, the staff performed its assessment of the meteorological aspects of the siting of the CRBRP facility at the Yellow Creek site utilizing onsite meteorological measurements and specific Yellow Creek diffusion analyses. The staff used these data in making the determination that the Yellow Creek and Clinch River sites were comparable and that both sites were licensable from a meteorological point of view.

NRDC-140--Meteorological Implications: The staff reiterates that the treatment of the meteorological implications of locating the CRBRP facility at Clinch River and at the four TVA sites is adequate to make the determination that all these sites are comparable and licensable from a meteorological point of view.

12.12.L.2 DOE Sites

12.12.L.2.1 Hanford

DOE-BB--Flow Rates and Population: The alternative site comparison of river flow rates and populations served have been revised, based on more complete site information. While the numerical factors have changed, the conclusions remain the same.

NRDC-144--Geology and Seismology: It is the staff's position, based on reviews it has conducted for nuclear power plants to be located on the Hanford reservation, that it would not recommend an SSE of less than that characterized by a Regulatory Guide 1.60 spectrum with a zero period anchor of 0.25 g for nuclear power plants to be constructed on the reservation.

The Columbia Plateau, within which the Hanford reservation is located, is very complex from a geological and seismological point of view. The level of seismicity is low when compared with regions of comparable size in the western

United States, but many of the tectonic structures there appear to be geologically young. Because of ongoing research in this area--by DOE, public utilities, and scientific agencies such as the USGS, the Washington State Geological Survey, and universities--considerable new information has become available, and new hypotheses about the tectonic evolution of the region are constantly coming forth. The proponents of each new nuclear facility here have been required to address the new information, hypotheses, and advances in the state of the art in geology and seismology. To do this has required extensive investigations to determine site-specific characteristics of each site and to determine how the geologic and seismic features of the site fit into the regional tectonic framework. These investigations have in the past cost many millions of dollars. It is anticipated that to validate the CRBR site at Hanford would require similar efforts.

NRDC-145--Hydrology: Hydrologic concerns in general receive a low weight because impacts from this rather small nuclear power plant are considered to be exceedingly minor. Because the weight of a particular plant siting factor should depend on its impact, no undue emphasis should be given to the relative superiority of the water supply at Hanford.

NRDC-146 and -147--Comparative Assessment: Under the NRC's proposed rule on alternate siting, the staff in its alternative site analysis is to seek an environmentally preferred alternative site as defined in Appendix K. The staff in its overall comparison of alternative sites concluded that no alternative sites promised sufficiently less adverse environmental impacts than the proposed site.

The staff has stated that from a meteorological point of view the Hanford site is preferable to the Clinch River site. A statement cannot be made however that the Hanford site is "substantially preferable" based on meteorological considerations alone. All of the various factors discussed in Section 2.1 must be compared before such a statement can be made. This comparison was made by the staff and the Hanford site was found not to be "substantially preferable" to the Clinch River site.

NRDC-148--Aquatic Ecology: The staff found that the Hanford site was environmentally preferable with respect to LMFBR construction-related impacts and environmentally comparable with respect to operational impacts. Although preferability of one site over another can be established for construction-related impacts, the staff finds that these impacts are typically temporary and largely mitigable. Therefore, the determination of preferability with respect to construction-related impacts in evaluating these two sites is of minor importance. This determination of preferability would not result in the determination that one site is "substantially preferable" over another.

NRDC takes the position that the presence of species that are afforded Federal and/or state protection and the potential for impact to striped bass at the Clinch River site in themselves establish environmental preferability of the Hanford site.

The staff has made the determination and the FWS has concurred in the determination that the Federally protected species present at the CRBR site will not be affected by plant construction or operation. The staff has determined that the construction and operation of the CRBR will not jeopardize the existence of

any State of Tennessee-listed species. The Tennessee Wildlife Resources Commission, although not concurring in this determination, has chosen not to comment on this assessment.

Finally, the staff has identified the potential impact to striped bass and has, with EPA, developed a program to eliminate this potential.

The staff concludes that no impact to either Federal and/or State of Tennessee-threatened or endangered species will occur and further concludes that losses to the striped bass population as a result of the heated discharge will be avoided. Therefore, these issues are not significant in the evaluation of alternatives.

NRDC-149--Socioeconomics: See response to NRDC-129 above.

12.12.L.2.2 Idaho National Engineering Laboratory

DOE-EE--Location: The text has been changed to reflect these comments.

NRDC-151--Geology and Seismology: The staff does not review the SSE in the FES, but in the SER. It is the staff's position that a Regulatory Guide 1.60 response spectrum with a zero period anchor of 0.25g is a conservative representation of the vibratory ground motion on rock for the CRBR controlling earthquake. The additional cost referred to is in the large scale geologic and seismic investigations that would be required of DOE to validate a CRBR site at INEL. In addition to a site investigation that would be comparable to that carried out at the Clinch River site, an extensive regional investigation would have to be done to determine the relationship of the site area geology to the regional tectonic framework around the Snake River Plain, which appears to be active. It is the understanding of the staff that design and construction costs increase with increased earthquake design bases, but an assessment of these cost differences was not made.

NRDC-152--Meteorology: The staff has stated that from a meteorological point of view the INEL site is preferable to the Clinch River site. The staff feels that the meteorological aspects of the alternate siting study comparing INEL to Clinch River have been properly factored into its assessment.

NRDC-153--Land Use: The staff's assessment is based upon extensive reconnaissance-level information. The staff does not concur with the commentator's conclusion that siting the LMFBR plant at the INEL site would be substantially preferable to siting at Clinch River site in terms of terrestrial resources.

NRDC-154--Socioeconomics: The staff made a comparison of each site individually with the CRBR site with respect to the magnitude of each category. A three-point scale was used to indicate judgmentally whether an alternative site was preferred to (+), comparable with (0), or less desirable (-) than Clinch River on the basis of each individual category. Then the staff determined the importance of each category at a site in terms of its potential impact to the community. Judging the preferability of Idaho versus Clinch River, labor force size and availability were determined to have most weight because of their

potential to adversely affect baseline community patterns. The second most heavily weighted factor was traffic congestion. The other factors were judgmentally determined to have the same weight.

NRDC-161--Socioeconomics: See response to NRDC-154.

12.12.L.2.3 Savannah River

NRDC-156--Hydrology: The staff arbitrarily chose a 50-mile limit as being a fair basis on which to judge hydrologic impacts. Because the alternative site reviews were restricted to reconnaissance-level information, without need to compile data from a wide area, the staff concluded that demographic data available within 50 mile of each alternative site would serve the purpose and 50 miles was a reasonable cutoff limit.

Because the staff's alternative site reviews were restricted to reconnaissance-level data, no detailed groundwater hydrologic data were available. The staff recognized, however, that because the Savannah River site is located in the coastal plain on deep unconsolidated sediments, it is not unlike many other sites in the southeastern United States which the staff has reviewed, and for which liquid pathway migration has not proven to be a problem.

NRDC-157--Water Quality: Additional detail on the water quality impact of a nuclear steam electric generating station can be found in the referenced FES for the Vogtle project. As noted on page L-2 under "Aquatic Ecology and Water Quality," the site characteristics that would render water quality considerations a significant factor in comparisons among sites would be whether abnormal mitigative controls would be required at one site or whether site usage would in some other manner adversely affect the efforts of state and Federal agencies to implement water quality objectives. Otherwise, it is considered that differences among a set of sites, each of which could accommodate the project without interfering with other water uses, should not weigh heavily in site selection.

NRDC-158--Meteorology: Based upon meteorological data collected at the Vogtle site, which is near the Savannah River site, it was determined that the Savannah River site has better diffusion conditions than the Clinch River site. Both the Clinch River site and the Savannah River site, have comparable tornado risks and are both located in Tornado Region 1.

NRDC-159--Endangered Species: The assumption is made that neither the American alligator nor the shortnose sturgeon is likely to be jeopardized by construction and operation of the LMFBR at the Savannah River alternative site. With this assumption, the sites are comparable. Should this assumption prove incorrect, the Savannah River site is environmentally less preferable than the Clinch River site. Thus there is little value in performing the endangered species assessment for Savannah River because without it, the proposed and alternative sites are merely comparable.

The striped bass issue is addressed in the response to NRDC-148.

NRDC-160--Terrestrial Resources: The staff considered the following factors in its analysis of the terrestrial resources at the Savannah River site (Appendix L,

Section 2.3.4.2): land uses (existing and proposed), floral and faunal characteristics, endangered and/or threatened species, prime and unique farmlands, and wetlands. The staff summarized the existing terrestrial resources at the Savannah River site and then compared these factors with similar factors for the Clinch River site. The staff believes that this approach provides sufficient detail and analysis to support its conclusion as stated in Appendix L, Section 2.3.4.2.

12.12.L.3 Conclusion

NRDC-163--Acceptability of Site: The staff's conclusion in the third paragraph on page L-47 that "all of these alternatives" (i.e., those discussed in Appendix L) "are probably acceptable as nuclear power plant sites" is based on the staff's judgment, using reconnaissance-level data, that these sites meet the threshold criteria listed in Section VI.2.b of NRC's proposed rule for alternative site reviews (see Appendix K, p. K-9). In the staff's opinion, the data supporting the staff's "subconclusions" and the overall conclusion concerning these alternative sites are adequately summarized in this document and the 1977 FES. The documents listed in the Appendix L Bibliography can be consulted by anyone seeking more details.

NRDC-164--Tables L.1 and L.2: Tables L.1 and L.2 are intended to present, in a simplified form, the staff's qualitative comparison of the alternative sites to the proposed Clinch River site. The supporting assessments are in the text of Appendix L.

The comment is correct that Table L.2 indicates the staff's judgment that licensing costs for the demonstration plant at the Murphy Hill and Yellow Creek sites would be comparable to those at the proposed Clinch River site. One should note, however, that this judgment is based on building the breeder plant at Murphy Hill in lieu of the coal gasification plant planned for that site, or at a similar site. Further analysis would be necessary if both facilities were constructed in the same vicinity (L.1.2.7).

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16. ABSTRACT (200 words or less) <p>This is a supplement to the 1977 Final Environmental Statement (FES) relative to construction and operation of the proposed Clinch River Breeder Reactor Plant at Oak Ridge, Tennessee. It provides the staff's assessment of additional data relative to the site and environs and modifications of the plant design and its fuel cycle which have occurred since the FES was issued. The staff's overall conclusion is unchanged; that is, that the action called for is the issuance of a construction permit subject to certain limitations for protection of the environment.</p>					
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